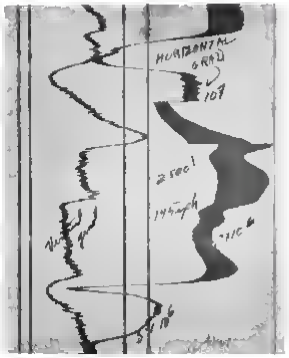
Aviation Week & Space Technology

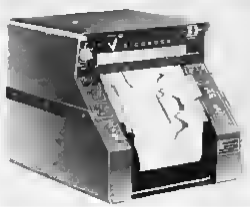
August 20, 1962

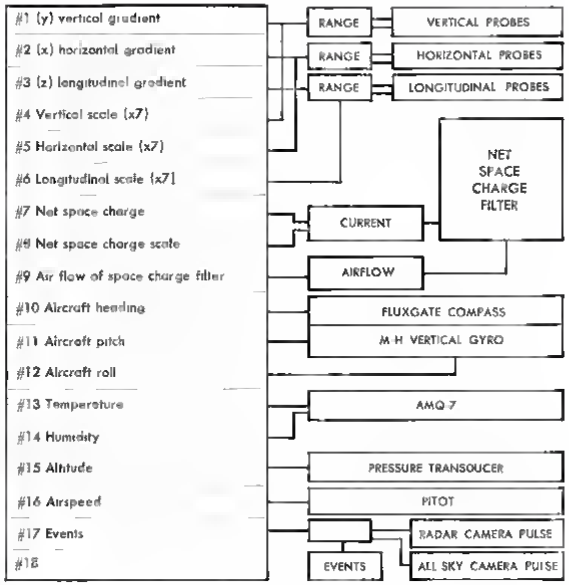
SPECIAL REPORTS:

- Sparrow 3
- Syncom Design

de Havilland Trident in BEA Markings







Which comes first...the lightning or the rain?

The Visicorder Oscillograph directly records electrical charges in the atmosphere.

What effect do electrical charges on the atmosphere have on cloud formation? What causes cloud droplets to grow into raindrops? Why does one cloud produce rain while another does not?

These questions are being answered in part by a Model 1108 Honeywell Visicorder Oscillograph, shock mounted in a C45 Beechcraft, flown 15,000 feet over cloud formations above an electrically-charged airspace in Central Illinois.

The Illinois State Water Survey has scattered a network of 50 rain gages across about 400 square miles downwind from 30 miles of small stainless steel wire stretched in a grid-like pattern 30 ft. above the ground. Seven power supplies energize the wire to about 20,000 volts with each supply having an output of 1 to 3 milliamperes.

Timelapse sky cameras, radar, and other observatory equipment make records of electrical fields, wind speed and direction. A low-flying Piper traces the plume of electrical charge as it rises from the ground; the Visicorder at 15,000 feet measures the movement of the charge in the higher air, how and where it scatters or dissipates, and what effect it has on the growth of cloud droplets.

Maybe your research project is not as glamorous as these weather studies, but if it is at all complex, or requires high speeds or sensitivities, or if you need to record many parameters simultaneously—or directly—the amazingly versatile Visicorder can do your job.

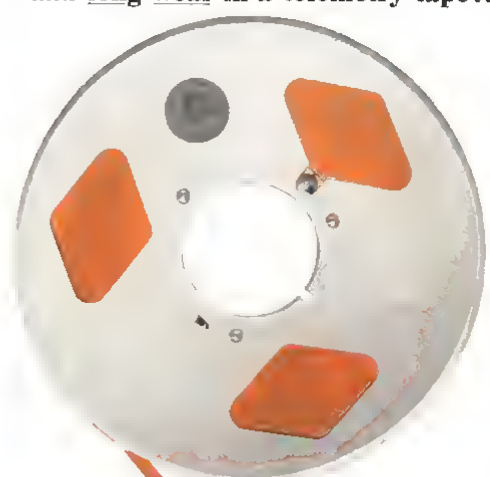
The schematic diagram of these cloud studies will give you an idea of the many capacities of the Visicorder.

For more details about the Model 1108 (24 channels) and other Honeywell Visicorders, write Minneapolis-Honeywell, Heiland Division, 4800 E. Dry Creek Road, Denver 10, Colorado. Our DDD phone number is 303-794-4311.

Honeywell

Honeywell First in Control

No one has ever combined high resolution *and* long wear in a telemetry tape...



until now.

In Soundcraft's new HRM Telemetry Tape outstanding short wavelength sensitivity and long wear are combined to give you flawless high data rate recording. Since long term wearability has been previously found only in heavy duty computer tapes, the achievement of this quality in HRM represents a major advance in the state of the art. In tests on conventional telemetry transports, it has been run 600,000 times without evidence of any signal deterioration. The specially developed "B" oxide coating operates through an extremely wide temperature, humidity and speed range without head fouling or deposit build-up on transports. Equals or exceeds requirements of MIL-T-21029-A for "B" oxide. Exclusive use of DuPont's polyester "*Mylar*" base contributes to strength and reliability. Complete data on request. **REEVES SOUNDCRAFT CORP.**

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AEROSPACE CALENDAR

Aug. 27-29—AIME Technical Conference on Advanced Electronic Materials, Benjamin Franklin Hotel, Philadelphia, Pa.

Aug. 27-Sept. 1—Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden.

Aug. 27-Sept. 1—Second International Congress, International Federation of Information Processing Societies, Munich.

Aug. 28-30—Fourth Conference on Maintainability of Electronic Equipment, Electronic Industries Assn. (in cooperation with Department of Defense), University of Colorado, Boulder, Colo.

Sept. 3-7—National Advanced Technology Management Conference, Institute of Radio Engineers, Seattle, Wash.

Sept. 3-7—International Symposium on Information Theory, Institute of Radio Engineers, Brussels, Belgium.

Sept. 3-9—1962 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-7—National Advanced Technology Management Conference, Opera House, Seattle World's Fair grounds, Wash. Sponsors: University of Washington, professional engineering groups and technologically oriented business firms.

Sept. 5-7—Symposium on Measurement of Thermal Radiation Properties of Solids, Biltmore Hotel, Dayton, Ohio. Sponsors: Aeronautical Systems Division, USAF; National Bureau of Standards, NASA.

Sept. 5-7—Seminar on Automatic Checkout.

(Continued on page 7)

AVIATION WEEK and Space Technology

August 20, 1962

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AEROSPACE CALENDAR

(Continued from page 5)

Techniques Battelle Memorial Institute Columbus, Ohio Co-sponsors Aeronautical Systems Division USAF Columbus, Ohio Research Center

Sept. 6-8—Second Annual Convention, Canadian Business Aircraft Assn., Queen Elizabeth Hotel, Montreal, Canada.

Sept. 10-14—Fourth National Conference on Applied Meteorology American Meteorological Society, Hampton, Va.

Sept. 10-14—Annual General Meeting, International Air Transport Assn., Dublin, Ireland

Sept. 13-14—10th Annual Engineering Management Conference, IRE, Hotel Roosevelt, New Orleans, La.

Sept. 17-18—Hydrofoil & Air Cushion Vehicles Meeting, Institute of the Aerospace Sciences, Shoreham Hotel, Washington

Sept. 18-20—Ordnance Environmental Research Symposium, El Tropicano Hotel, San Antonio, Tex. Sponsor: Environmental Research Office of the Office of the Chief of Ordnance. Arranged by Southwest Research Institute

Sept. 18-23—16th National Convention & Aerospace Panorama, Air Force Assn., Las Vegas, Nev.

Sept. 19-20—Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences, Hotel Commodore, New York.

Sept. 19-20—Operations & Maintenance Symposium, Airwork Corp., Millville, N. J.

Sept. 19-20—11th Annual Industrial Electronics Symposium, Sheraton Hotel, Chicago, Ill. Sponsors: IRE, American Institute of Electrical Engineers, Instrument Society of America

Sept. 19-21—Sixth National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsor: Advisory Group on Electron Devices

Sept. 19-22—Second International Agricultural Aviation Congress, National Superior Agronomy School, Grignon, France

Sept. 24-28—13th International Astronautical Congress, American Rocket Society, Sofia, Bulgaria

Sept. 24-Oct. 12—International Air Transport Assn. Traffic Conferences, San Marcos Hotel, Chandler, Ariz.

Sept. 25-27—Third Annual Symposium on Helicopter Open Sea Rescue, Kaman Aircraft Corp., Bloomfield, Conn. Sponsor: Naval Air Material Center, Air Crew Equipment Laboratory

Sept. 25-28—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.

Sept. 26-27—Symposium on the Physics of Failure in Electronics, Illinois Institute of Technology, Chicago, Ill. Co-sponsors: Rome Air Development Center, USAF Systems Command, Armour Research Foundation

Sept. 26-Oct. 2—1962 General Conference, Federation Aeronautique Internationale, Athens, Greece

Sept. 27-28—Symposium on Dynamic Behavior of Materials, University of New Mexico, Albuquerque, N. M. Sponsors: University of New Mexico, American Society for Testing and Materials

(Continued on page 9)

AEROSPACE CALENDAR

(Continued from page 7)

Sept 27-28—Symposium on the Dynamic Behavior of Materials. American Society for Testing and Materials, University of New Mexico, Albuquerque, N. M.

Sept. 28-29—Society of Experimental Test Pilots' Sixth Annual Awards Banquet & Symposium, Beverly Hilton Hotel, Beverly Hills, Calif.

Oct. 1-3—Seventh Annual Exposition & Symposium. Air Traffic Control Assn., Flamingo Hotel, Las Vegas, Nev.

Oct. 1-3—National Communications Symposium. Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 2-4—Symposium on Physics and Nondestructive Testing. Granada Hotel, San Antonio, Tex. Arranged by Southwest Research Institute.

Oct. 2-4—Third Symposium on Advanced Propulsion Concepts. Cincinnati, Ohio. Co-sponsors: AFOSR, General Electric.

Oct. 2-4—National Symposium on Space Electronics and Telemetry. IRE, Fontainebleau Hotel, Miami Beach, Fla.

Oct. 2-4—15th Annual Meeting and Convention, National Business Aircraft Assn., Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 8-10—18th Annual National Electronics Conference & Exhibition. McCormick Place, Chicago, Ill.

Oct. 8-12—National Aeronautic & Space Engineering & Manufacturing Meeting & Display. Society of Automotive Engineers, The Ambassador, Los Angeles, Calif.

Oct. 9-11—National Airports Conference. American Assn. of Airport Executives, University of Oklahoma, Norman, Okla.

Oct. 10-12—Ions in Flames & Rocket Exhausts Conference, American Rocket Society, Palm Springs, Calif.

Oct. 10-12—20th Annual Aerospace Electronics Exposition/Report. Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 15-17—Fall Meeting. International Scientific Radio Union & Institute of Radio Engineers, Ottawa, Canada.

Oct. 15-17—ASW Meeting. Somerset Hotel, Boston, Mass. Sponsors: Institute of the Aerospace Sciences, U. S. Navy.

Oct. 15-18—International Symposium on Space Phenomena and Measurement. Statler Hilton, Detroit, Mich. Ninth Annual Meeting. Institute of Radio Engineers, co-sponsored by NASA and AEC.

Oct. 26-27—17th Midwest Quality Control Conference. American Society for Quality Control, Denver Hilton Hotel, Denver.

Oct. 29-30—Meeting on Large Rockets. Institute of the Aerospace Sciences, El Dorado Inn, Sacramento, Calif.

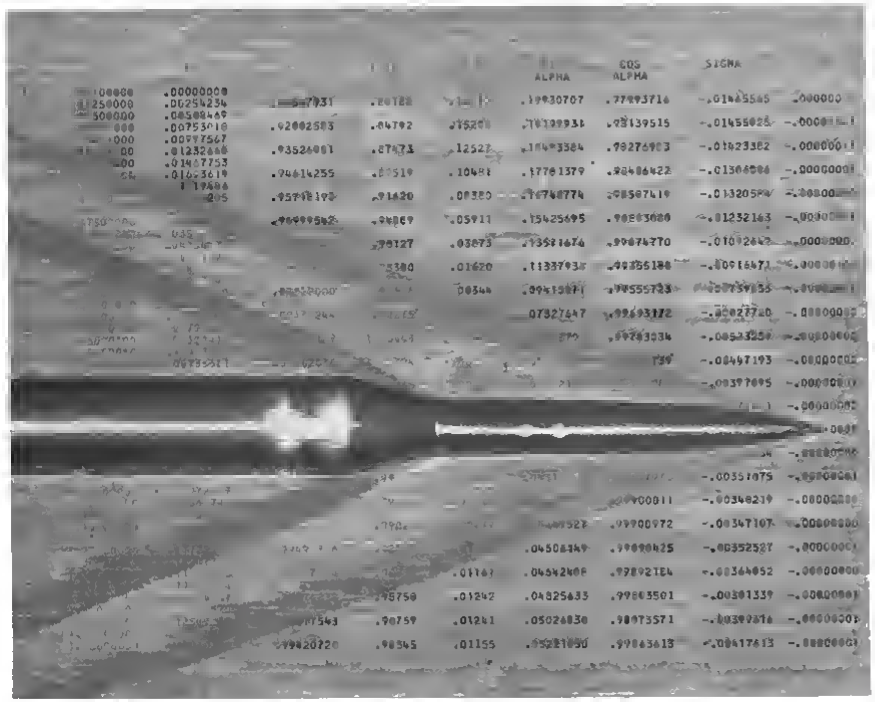
Oct. 29-31—Symposium on Dynamics of Manned Lifting Planetary Entry. Philadelphia, Pa. Attendance limited. For information: Sinclaire M. Scala, General Electric Co., MSVD, Valley Forge Space Technology Center, Box 8555, Philadelphia 1, Pa. Co-sponsor: AFOSR.

Oct. 29-Nov. 2—International Symposium "Basic Environmental Problems of Man in Space." UNESCO House, Paris, France. Sponsors: International Astronautical Federation, International Academy of Astronautics.

A basic problem facing the designers of submersible, sea-going, air-cushion, flying or space-seeking vehicles is the resistance of the liquid or gaseous fluids through which these craft must pass. The shape of the vehicle becomes critical in determining its speed and efficiency.

□ Research on fluid dynamic shapes at Douglas Aircraft Division laboratories is among the most advanced in the world. Included are studies and experimental work relating to submarines, ships, subsonic, supersonic and hypersonic aircraft, and manned re-entry space-planes. Also under present development are new computer methods of calculating the potential flow and heat about arbitrary bodies throughout the speed spectrum and solving the various configuration problems which are involved.

THE SHAPE OF SPEED
...AND WHAT DOUGLAS IS DOING ABOUT IT

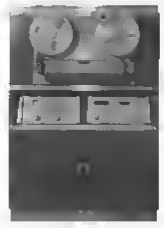


Douglas leadership in the above field has evolved from wide experience in the design of aerodynamic vehicles over the past 40 years. The advanced study of fluid dynamics is among more than 500 research programs under way at Douglas.

DOUGLAS

Who helps him make picture landings—and then shows the picture? AMPEX.

He landed four tons of supersonic steel on a moving carrier that looked like a miniature matchbox from 20,000 feet. It took skill, daring—and an assist from an Ampex VR 1000 Videotape* recorder. This advanced recorder and camera system gave carrier landing personnel a complete picture of the pilot's progress, helped talk him down with greater precision. Now that he has landed, it lets him see the whole operation recorded on Ampex videotape. He watches his approach, has an exact record of his speed, hears his conversation with landing personnel. Next time he'll make a safer, surer landing. The Navy calls this PLAT (Pilot Landing Aid Television). It was developed by Com Air Pac with Ampex. And it's one of the many ways videotape recorders are now being used for education and training in every area. For details on an Ampex videotape recorder to meet your needs, write the only company providing magnetic recorders and tape for every application: 934 Charter St., Redwood City, California. Sales and service engineers throughout the world.



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*TM Ampex Corp.

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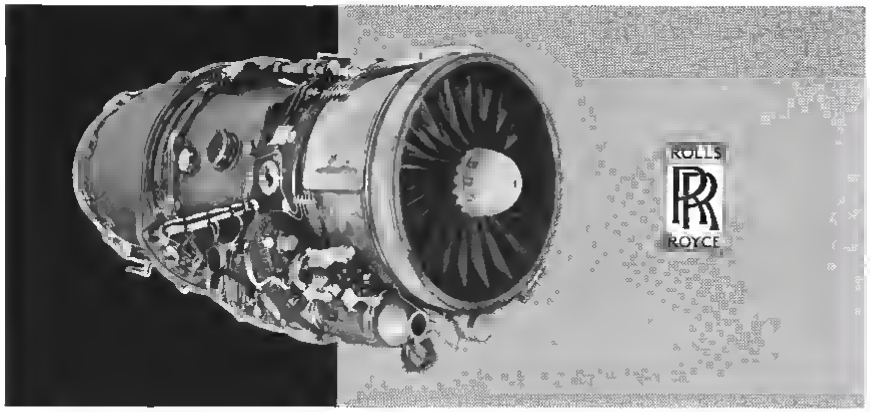
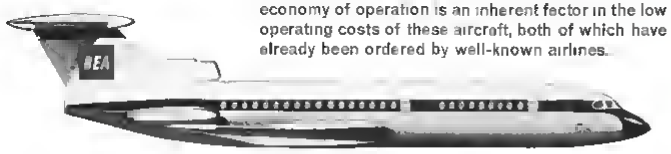
SPEY
BY-PASS JETS

powering short and medium haul airliners



The Spey, based on twelve years of Rolls-Royce experience with by-pass (turbofan) jets, is now flying in the de Havilland Trident and has also been selected to power the new BAC One-Eleven. The Spey's economy of operation is an inherent factor in the low operating costs of these aircraft, both of which have already been ordered by well-known airlines.



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Designed for reliability and flexibility at temperatures ranging from —65° to 450° F, Stratoflex Super-T medium pressure Teflon hose and Super T-HP high pressure Teflon hose exceed the rigid requirements of MIL-H-25579 and MIL-H-8788 (ARP 604) respectively. The stainless steel braided cover hose and inner tube of Teflon has an operating range of 1500 PSI to 3000 PSI and is unaffected by all fuels or synthetic base lubricants, acids, solvents, alcohols and coolants. Non inflammable.

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*Teflon is a registered DuPont trademark

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With the STOL Caribou AC-1

The Caribou's slow speed under full control, and straight-out rear exit permits accurate delivery and close grouping of logistic supplies.

Four 1500-lb. pallets can be dropped in rapid succession to land within a concentrated area.

Air drops of jeeps and 3000-lb. pallets have been successfully demonstrated.

SHORT FIELD PERFORMANCE

The AC-1 hauls loads up to 4 tons in and out of tiny rough combat-area strips. Zero-wind landing roll is 670 feet . . . take-off, 725 feet at 28,500 lb. gross weight. Whether the mission calls for STOL delivery or air drop, the Caribou offers unsurpassed logistic close support.

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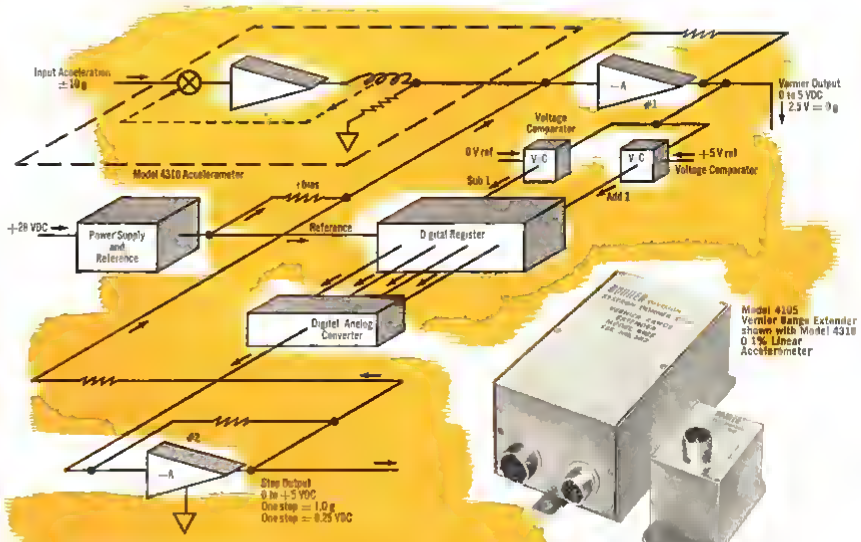
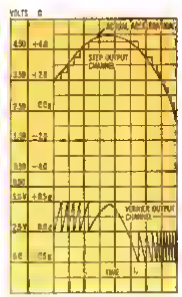


Can you resolve ±12 g's acceleration to 0.04 g over a 2% telemetry system?

Yes, if you use the new Donner 4105 Vernier Range Extender. Coupled to the Donner 4310 linear force balance accelerometer, this remarkable device yields up to a 12-fold increase in resolution compared to methods currently used in today's telemetry systems.

In operation, the Model 4105 provides two distinct 0-5 vdc outputs for transmission over two telemetry channels. One output generates ±1.0 g steps of measured acceleration, the other resolves the difference between steps to 0.04 g. For example, over a 2% telemetry link, the resolution possible with a ±12 g Model 4105 is 2% of ±1 g or 0.04 g. Using an ordinary ±12 g accelerometer over the same telemetry link, the best possible resolution is 2% of ±12 g or 0.48 g—or 12 times worse.

The Model 4105 also offers fast response which allows tracking a 1 g/0.0004 second rate of acceleration change without loss of step on the step output channel.



KEY SPECIFICATIONS

WEIGHT 2.5 pounds
INPUT POWER +28 vdc ±2 vdc
OUTPUT Two 0-5 vdc channels
RANGES AVAILABLE ±0.05 g to ±35 g

For More Information—Please write for full technical information of the economically priced Model 4105 or contact your nearest Donner engineering representative.

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For your limited space applications you can now specify the new QSR, porous-anode Tantalytic® capacitor, with the largest μf capacity in a cubic-inch tantalum unit. It stores 5200 μf (6v) in a cubic inch, yet only weighs 65 grams.

Operating ranges are 6 to 60 volts, 800 to 5200 μf, and —55 C to 85 C. It is supplied in polar form.

Non-acid gelled electrolyte has healing properties without liquid acid dangers. Leakage current in the QSR capacitor actually decreases with time.

Hermetically sealed, the QSR unit is unaffected by external moisture. Helps prevent drying out of electrolyte, too. Brackets are constructed so the terminal can be put on any side, top, or bottom.

Other porous-anode capacitors are available in five case sizes to meet all your low voltage needs. Ratings are 6 to 60 volts, 0.1 to 325 μf. All provide low impedance per unit volume. All use the gelled, non-acid electrolyte, and they're low in cost.

Ask your G-E Sales Engineer today why you get greater value when you specify one of General Electric's porous-anode Tantalytic capacitors. Ask him for bulletin GET-2978, too. Or write to Section 430-12, General Electric Co., Schenectady, New York. *Capacitor Department, Irmo, South Carolina*

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August 20, 1962

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COVER: Flight test program of the de Havilland DH 121 Trident three jet transport reached the 240-hr. mark last week with two airplanes flying and a third scheduled to join them early in September. Aircraft shown in British European Airways markings is the No. 2 Trident. Black spots aft of the cockpit on top of the fuselage are two ADF antennas.

PICTURE CREDITS
Cover—Russel Adams, de Havilland Aircraft Co.; 26, 27, 30—Aviation Week; 29—(top, bot) Wide World; 29 (middle), 30—UPI; 32, 33—Ryan Aeronautical Co.; 35—Lockheed; 52 (right) 55, 57—Raytheon; 53—McDonnell Aircraft Corp.; 60—David Anderton; 61 (right)—David Anderton (left) Raytheon; 62—U. S. Navy; 67—Underwoods (top)—Wide World (bot); 70—Bleak Star; 71 (top)—Aviation Week (bot)—Wide World; 75—Wide World; 80, 81, 83, 85, 87, 88—Hughes Aircraft Corp.; 81 (bot)—Aviation Week; 93, 94, 95—Gendix Corp.; 99, 103—Goodyear Corp.; 104, 105 (top), 106—Nord Aviation; 105 (bot)—Arthur Erikson.

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Vostok's Double Warning

The Soviet Union has written another significant chapter in the history of manned exploration of space with the performances of Maj. Nikolayev and Lt. Col. Popovich in Vostoks 3 and 4. The Soviet space team has executed this new step forward in manned space flight with an operational precision that must command respect from space technologists everywhere. There is still considerable pertinent data missing on the Soviet space team's performance and it is unlikely that the Soviets will ever provide anything approaching the complete technical reports that have followed every U.S. Project Mercury manned flight.

However, a number of important facts have already emerged from this remarkable performance of the twin Vostoks. First, the nature of this Soviet manned space mission came as a complete surprise to Western technologists regardless of what they may say after the fact.

The surprise itself is significant, for it indicates that no matter how much the West thinks it knows about the Soviet space program, the sum total of this knowledge is really pitifully small. The Soviets show every intention of keeping it as small as possible without shutting off completely their own entree into international scientific circles.

The nature of the surprise is even more significant because it shows that the Soviets are ready to develop the operational technique of rendezvous in space now. This is in contrast to the NASA program, which aims at beginning rendezvous experiments with Gemini sometime in 1964. Rendezvous, whether in earth orbit or in lunar orbit, is unquestionably the next key to the extension of man's sphere of useful operations in space. The fact that the Soviets can rendezvous now with spacecraft carrying almost three times the present weight of the Mercury capsule and about twice that of the future Gemini certainly gives the Russians a far more advanced platform from which to conduct operations in the lunar and planetary areas. The Soviets have also demonstrated an orbital launch capability with their Venus probe, fired from a parking orbit last year with considerable precision and accuracy.

Thus the rendezvous technique has enormous importance both for the race to a manned lunar landing and for the military use of space. And it is a technique in which this country is badly lagging, both in the NASA program and in the military sphere, where USAF's efforts to develop a manned satellite interceptor program have been firmly vetoed by the White House and Defense Department, even in their study phase.

Another major point scored by the twin Vostok performance is in the bioastronautics area where another parcel of doubts as to man's ability to live and function usefully for extended periods in space has been dissipated. The lively performance of Maj. Nikolayev and Lt. Col. Popovich during their four and three days, respectively, in orbit certainly confirms the feeling of Mercury Astronauts Glenn and Carpenter that weightlessness poses no real threat to extended space flight and that Maj. Titov's severe nausea was an exception rather than the rule. The Soviet life support system capability for long space flights was thoroughly demonstrated, with performance far past the longest possible emergency limits of the Mercury capsule's optimum capability. In bioastronautics, too, the U.S. program both in NASA and the military is still in an organizational and operational mess, that may prove to be the critical limiting factor in our own manned space flight progress unless drastic remedial action is forthcoming immediately.

But from an American viewpoint, the most significant aspect of the Soviet twin Vostok performance is the belly clutching fear it has stirred in the top level government circles that know the whole story of the Soviet space ships' performance (see page 26) and their frightened attempts to sweep the whole matter under the rug of official secrecy. The reaction of the Kennedy Administration to the Vostok rendezvous mission has been sickeningly similar to that of the Eisenhower Administration's reaction to the early demonstrations of Soviet ballistic missile capability and the Soviet entry into space. Both in the White House and the Defense Department the reaction of top officials to major problems that vitally affect the security of the American people is increasingly to wrap them in a blanket of official secrecy. When that fails, as it inevitably must in a democratic society, their first move has been to set the police dogs barking on the heels of the radio, television and press men who have exposed official bungling to public view. This shameful misuse of the Federal Bureau of Investigation and military police to shadow working newspapermen and frighten public officials into silent acquiescence is more in keeping with the atmosphere of Soviet Russia, and has no place in a truly democratic government.

Equally bad is the Defense Department's space secrecy directive (AW May 21, p. 26), which ostensibly is aimed at keeping military space launches secret, but which actually imposes an ironclad "need to know" restriction across the entire spectrum of space technology. This directive, too, belongs more to the philosophy of oriental communism than to either the scientific spirit or democracy. This "need to know" clause in the secrecy directive will actually do more to slow technical progress in this area than anything a foreign agent could do to disrupt our space effort. It will undo quickly all of the progress that NASA has made in showing the world how our scientific programs can operate in an atmosphere of untrammeled freedom and international cooperation.

Official secrecy is never a solution for unpleasant problems. It is rather sad to see the Kennedy Administration naively grasping at this structurally unsound straw in its hour of need, instead of realistically apprising the American people of how serious this problem really is and recommending a clear cut program of action to overcome it. It would indeed be ironic if the epitaph of the Kennedy Administration finally read that while it was concentrating on fighting a tiny jungle war in Southeast Asia it failed to understand the Soviet challenge in outer space and allowed the free world to be enveloped from above.

—Robert Hotz

WHO'S WHERE

In the Front Office

Carter L. Burgess board chairman, American Machine and Foundry Co., New York, N. Y., succeeding the late Morehead Patterson. **Rodney C. Gott** succeeds Mr. Burgess as president; Frank P. Downey succeeds Mr. Gott as executive vice president.

Kenneth E. Hunter, vice president and general manager, Hycon Manufacturing Co., Monrovia, Calif.

W. Jerome Kane, vice president and general manager, Boeing International Corp., Seattle, Wash., a subsidiary of The Boeing Co.

L. E. Tollefson, executive assistant to the president, Douglas Aircraft Co., Inc., Santa Monica, Calif. **John R. Allen** succeeds Mr. Tollefson as vice president-Washington (D.C.) Operations. **John R. Rogan** succeeds Mr. Allen as vice president general manager, Tulsa (Okla.) Division.

C. F. Pitts, vice president and assistant general manager, Astronics Division, Lear Siegler, Inc., Santa Monica, Calif. Also appointed vice presidents of the Division: **H. C. Bream** for marketing; **T. M. McAuliffe** for manufacturing; **L. A. Payne** for engineering.

Billy R. Bryant, president and treasurer, Carlock of California, Glendale, Calif., a division of Carlock, Inc.

Robert M. Thomas Jr., senior vice president and general manager, The Thomas & Betts Co., Elizabeth, N. J.

Robert E. McGinty, vice president and director of administration, C. T. Schjeldahl Co., Northfield, Minn., and **Earl J. Wing**, treasurer.

William F. Sauers, vice president of the newly established Management Engineering and Controls Division of Autonetics, Downey, Calif., a division of North American Aviation, Inc.

The Transistor Products and Components Divisions of Texas Instruments, Inc., Dallas, Tex., have been combined into the Semiconductor/Components Division and Vice President **Cecil Dotson** has been appointed director. Also Vice President **Jay Rodney Reese** now manager of the International Division.

Lt. General G. A. Blake, Director, National Security Agency, Fort Meade, Md. Also **Brig. Gen. L. W. Fulton**, Director, Procurement & Production, AF Logistic Command, Wright-Patterson AFB, Ohio.

Honors and Elections

Recipients of the 1962 **Harmon International Aviation Trophies**, for outstanding and extraordinary feats of individual piloting skill during 1961, are: **Aviator's Award** to Lt. Col. **William R. Payne**, USAF, who piloted a Convair B-58A bomber to two international speed records; **Aviatrix Trophy** to **Jacqueline Cochran**, who established eight "world class" records with a Northrop T-38 and flew a Lockheed F-104 twice the speed of sound; **Aeronaut's Trophy** to Cmdr. **Malcolm D. Ross**, USNR, and the late Lt. Cmdr. **Victor A. Prather**, USN Medical Corps., who attained the highest altitude ever attained by a manned balloon.

(Continued on page 108)

INDUSTRY OBSERVER

► Horizontal tailplane of the No. 3 Hawker P.1127 has been modified to change the configuration to 20 deg. negative dihedral, rather than straight as on the two aircraft now flying. The fix is a fairly standard solution to pitchup problems. Negotiations have been completed to convert a Vickers Valiant V bomber into a flying testbed for the P.1127's Bristol Siddeley BS.53 vectored thrust engine. Test flights will begin this fall in a move designed to speed engine development.

► **S-16 Orbiting Solar Observatory, launched Mar. 7, has made direct observations of more than 75 solar flares. Analyses are being made to determine which emitted hazardous radiation.**

► Technical evaluation of industry proposals for USAF's multi-million dollar airborne geodetic mapping system, USQ-28 (AW Aug. 13, p. 83), is expected to be completed late this month. Ten aerospace companies submitted proposals for the program, including AC Sparkplug, Aeronutronic Division of Ford, Autonetics Division of North American, General Electric, General Precision, Kollsman, Litton Industries, Minneapolis-Honeywell, Nortronics and Republic Aviation.

► **Second prototype of the Beagle 206 executive twin, the enlarged version designated the 206Y (AW May 7, p. 116), made its first flight last week. The 206Y, which will be the production version, has five feet added to the wingspan, and the gross weight has been increased to 7,000 lb. The tailplane is slightly larger, and an extra seat has been added. Prototype Beagle 218, a four-seat twin (AW Aug. 28, 1961, p. 32), is scheduled to make its first flight this week. Both airplanes will be shown for the first time Sept. 3 at the Farnborough Air Show.**

► Specially equipped RC-135 with an improved airborne optical system for better photographic and television recording of nuclear tests and missile launching and re-entry has been proposed to the Military Air Transport Service by the Air Force Photographic and Charting Service. Proposal calls for the development of improved optical stabilization system and 200 to 1,000 in. focal length lenses. System would be capable of providing pictures of orbiting satellites. RC-135 would be able to operate at altitudes up to 45,000 ft., above most haze and cloud cover.

► **Defense Department will seek speedy implementation of an operational military low-altitude communications satellite system under the re-oriented Advent program because of growing concern over the loss of long-range communications circuits due to sunspot activity which will reach its peak in the next three years.**

► Navy is widely dispersing ships that make up task forces at sea and augmenting their radar returns to provide protection against surprise nuclear attack. Radar augmentation makes each vessel appear to be the size of an aircraft carrier. Dispersal is designed to confuse enemy search radars since normally the North Atlantic, Mediterranean and Western Pacific are so congested with commercial vessels that radar returns present a confused pattern which prevents separating warships from merchantmen.

► **Tooling and jigs for the Lear SAAC-23 turbojet are being cleared out of the company's Swiss plant and prepared for shipment to the new Wichita, Kan., facility (AW June 11, p. 30). Initial shipment is due to arrive next month. Prototype of the 6-8 place twin-jet executive aircraft probably now will begin its flight test program in the U.S., rather than in Europe.**

► Open ocean wave and swell patterns are presenting the greatest obstacle to the practical operation of small ground effect machines (GEMs) at sea. Choppy waves and long swells can be surmounted, but other combinations cause unfavorable oscillations to start, which usually result in some part of the craft touching the water. Salt spray often causes immediate partial loss of power when ingested by an engine. Designers now are predicting that the only workable open ocean GEM design will be a 400-ft.-dia. craft riding 40 ft. above the mean water level.

Washington Roundup

Soviet Space Threat

Soviet Defense Minister Marshal Rodion Malinovsky tossed a military warning for other nations into his congratulations to Cosmonauts Andrian Nikolayev and Pavel Popovich for their dual flights in Vostoks 3 and 4 (see p. 26), "Let our foes know what technology and what militance are in possession of our Soviet power." The pilots, both Red Air Force officers, were decorated last year with the Order of the Red Star for "successful fulfillment of a government assignment." Lack of an explanation of the assignment has started speculation in Moscow that both men have flown suborbital space missions.

Lunar missions meeting sponsored by the National Academy of Sciences at Blacksburg, Va., last week was an attempt by National Aeronautics and Space Administration to stimulate thinking on experiments which have the best scientific potential for the Apollo manned lunar landing program. NASA is concerned over sniping at the program by some scientists and it reasons that if such critics as Dr. James A. Van Allen and Dr. Harold Urey would help plan experiments, the criticism would decrease considerably.

Advent Management

Management of the Advent military communications satellite program remains under fire despite the recent reorganization ordered by the Defense Department. Basic issue is whether the new management is any better than the old. Army Brig. Gen. J. Wilson Johnston, former Advent project manager, last week said publicly what Army officials have been saying privately for weeks—that what the program has needed and still needs is one over-all boss who could cut across service lines and deal directly with the contractors.

Gen. Johnston admitted that Army's management setup was cumbersome. **But he told a special House space subcommittee that the machinery** was just beginning to work smoothly last May when Defense Secretary Robert McNamara ordered a new arrangement that gave Air Force a larger role and Army a lesser one (AW June 18, p. 32).

Subcommittee Chairman Joseph Karth pinned down the fact that the first Advent satellite had run into so many technical difficulties that it would not have been ready to fly on time even if the Centaur booster had been. The 'greatest problem in terms of absolute dollar amounts and technical difficulties' was presented by the contract with General Electric for the satellite vehicle, Gen. Johnston said. He also said Army had recommended decreasing Advent's weight long before Defense Department made the decision.

McNamara: Two Views

Secretary McNamara's dilemma on the centralization of Defense Department functions. **Chairman Carl Vinson of the House Armed Services Committee** endorsed a subcommittee report last week which said the Secretary is fostering a "no decision" attitude in the military services by moving "the decision making process higher and higher on the scale of centralized authority and into the hands of a few people" at the Defense level. The report proposed legislation requiring congressional approval of any further centralization. But the Senate Armed Services Committee praised the centralization moves in a report on military construction, saying "It is gratifying to note that the Secretary is making use of the authority the Congress has vested in him to streamline the Defense establishment."

Plan for a reorganization of the office of Chief of Naval Operations has been sent to Secretary of the Navy Fred Korth by a study committee, but contrary to Pentagon rumor, the post of deputy chief for air is not to be abolished when Vice Adm. Robert B. Pirie retires on Nov. 1. The nomination of Vice Adm. William A. Schoech, now commander of the Seventh Fleet in the Western Pacific, has been sent to McNamara for his approval.

Long Playing Senator

Sen. Russell B. Long, one of the leaders of the pro-public ownership filibuster against the Administration's public-private communication satellite ownership bill, warned the Senate last week that Russia may orbit a communication satellite within a month, call it a "people's satellite," open it to free phone calls from anyone anywhere, and sing over it to the tune of "The Best Things in Life Are Free":

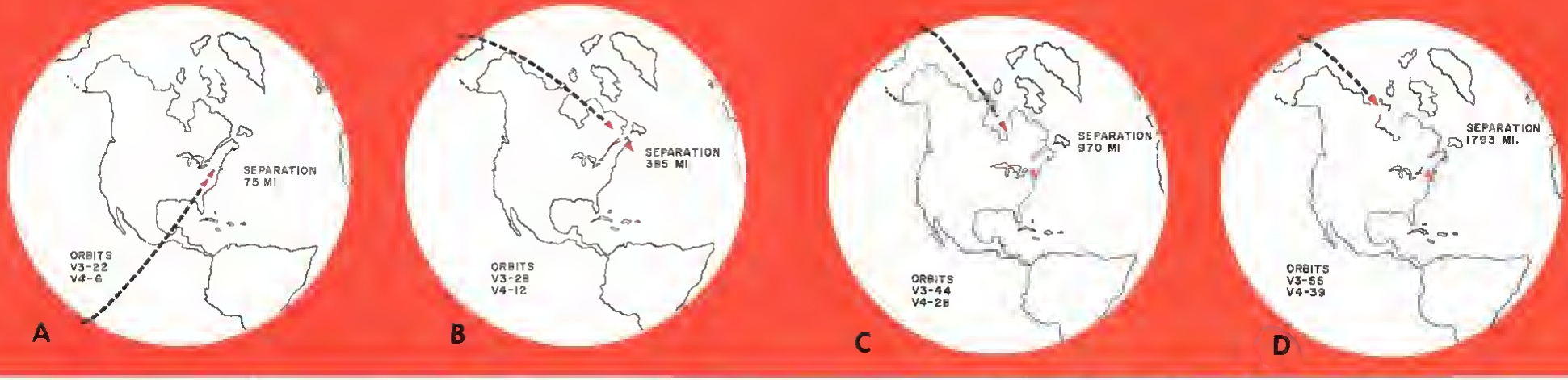
> You're listening to the people's star; It's put there for you and me,
> Don't tune in on that satellite—it's owned by AT&T.

Possible consequences of Red China's acquiring a tactical nuclear capability by the late 1960s are being studied for Air Force by the Rand Corp.

NASA has asked the Defense Department to give it one RS-70 bomber to be used for aeronautical research in a program similar to that of the X-15.

Quote of the week in reaction to the flights of the Soviet Vostoks came from Rep. Olin Teague, chairman of the House space committee's manned space flight subcommittee, who said: 'Our space program is on solid ground."

—Washington Staff



SOHIO RESEARCH CENTER Doppler radio plots of Vostok 3 (leading) and Vostok 4 over U.S. show gradually increasing separation. Maps plot (left to right) first fix noon Aug. 12, third fix at 9:05 p.m. Aug. 12, sixth fix at 8:30 p.m. Aug. 13, and ninth fix at 8:04 p.m. Aug. 14.

Vostoks 3 and 4 Rendezvous, Dock in Orbit;

Washington—U.S. evidence that Vostoks 3 and 4 rendezvoused and docked in earth orbit is forcing the nation to make an extensive re-evaluation of military and civilian roles in the space program. Neither the U.S. nor the Soviet government had reported the docking by late last week, although Russia said the two Vostoks had been in visual contact.

Extreme secrecy measures were imposed to keep U.S. government officials from commenting on details of the rendezvous and docking feat, but officials were free to discuss their reactions on the significance of the dual launching in relation to U.S.-Soviet space race.

Early in the week, top Administration officials debated whether to release the fact that a docking had been achieved. The decision not to do so was based on a desire to avoid official recognition of the significance of the Russian achievement and also to avoid giving the USSR a measure of U.S. intelligence.

Foreign tracking stations in Japan and Great Britain reported early in what Russia called the "group flight" that radar returns from the Vostoks appeared as a single blip.

The Soviet feat of injecting two manned spacecraft into precise, matching orbits within 24 hr., and keeping them in group flight for nearly 71 hr., produced these major developments:

- **Admission in the U.S.** that the military implications of the Soviet space program are becoming clear, particularly with the demonstration by Vostoks 3 and 4 of an ability to inspect, and the potential to kill, orbiting vehicles (see p. 25). U.S. position has been to de-emphasize the military aspects of space.
- **Attempt** by the National Aeronautics and Space Administration to reassure the Western world that the U.S. program is driving forward. James E. Webb, NASA administrator, said flatly that the U.S. will be the first country to land men on the moon.

Several government officials, including Brainerd Holmes, NASA's director of Manned Space Flight, and Deputy Defense Secretary Roswell Gilpatric, belittled the importance of the Soviet dual flight. Holmes said the latest Vostok missions "are not particularly significant" in the manned lunar landing program, and Gilpatric said the U.S. has a "leg up" on the Russians. "I am not throwing in the sponge in the space race yet," Gilpatric said.

- **Conclusion that the Vostok** launch vehicle was more powerful than earlier Soviet space boosters, and that the booster was man-rated in the seven-shot Cosmos satellite series.
- **Conjecture that USSR** will refine rendezvous and docking techniques, probably with two men in each spacecraft, in their next manned mission.
- **Demand by Sen. Howard W. Cannon** (D-Nev.) for a larger military space role (see p. 31). Sen. Cannon made his demand in a speech drafted in consultation with key Administration officials and it had the blessing of Chairman Richard B. Russell (D-Ga.) of the Senate Armed Services Committee.
- **Increased attempts** by Republican spokesmen to make a political issue of President Kennedy's emphasis of the peaceful uses of space. Sen. Barry Goldwater (R-Ariz.), chairman of the Republican Senatorial Campaign Committee, told AVIATION WEEK the Vostok flights "give us more reason than ever to hammer away on this point. If the Russians can achieve docking and we can't, our goose is cooked."

Probably the most striking implication of the Russian feat comes within the Administration itself, where military and civilian backers of an expanded military space role feel that it may be enough to win over their principal opponents—the President, Defense Secretary Robert S. McNamara and Director of Defense Research and Engineering Dr. Harold Brown.

McNamara and Brown have opposed all efforts for a separate military manned space flight program, but USAF has never been able to present an organized front for an increased space role.

The Vostok flight was made at a time when the 1964 budget is being shaped. The Administration's budget recommendations will be made final by the end of next month, and the impetus of the Soviet space achievements may be enough to consolidate the USAF position on space to the point where it would be accepted. One USAF official anticipates that a "massive attack" on public opinion will begin next month to sell the requirements for manned satellites and space stations and unmanned communications and reconnaissance satellites.

Meanwhile, the secrecy clampdown on what the U.S. has learned specifically about the Vostok flights is as severe as that which covers results of photography returned by Samos satellites. Defense Department and service offices which normally receive tracking information from the North American Air Defense Command have been taken from the distribution list of reports on recent Soviet space activities. This was done on McNamara's recommendation and President Kennedy's approval.

Within the Air Force, deputy chiefs of staff were instructed not to refer to the Soviet cosmonauts, and not to respond to questions about them.

There is fear in the Pentagon that the secrecy move could backfire if the public should conclude that the U.S. has inadequate capability for detecting and assessing Russian space activities.

Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, told AVIATION WEEK he believes the Vostok flights will act as a net gain to the U.S., because they will dissolve any complacency that may have arisen in this country due to the long interval between Soviet manned shots.

Welsh said all Russian space shots have a military significance, and it is a mistake to draw a distinction between one launch and another.

The Vostok flights, he said, "indicate a competence in space, but they did not show us anything that surprises us. I'm astonished that they haven't sent men into space for so long. I had anticipated that they would have sent two men up in a single capsule with a capability for maneuvering."

The fact that two men were launched in separate spacecraft "is not twice as impressive as sending up one man in a capsule or as impressive as if two had been sent up in the same capsule," Welsh said. He said the mission shows "careful planning, and a decision to make a space spectacular."

Dr. Hugh L. Dryden, deputy NASA administrator, said he does not know if the USSR attempted to dock the two Vostoks, but he thinks if a rendezvous and docking had been accomplished, "they [Russia] would have announced it."

Webb added credence to the possibility of "bringing military space into the mainstream" of active hardware programs. He said he can understand the concern of Defense Department officials who contend there is not enough military activity in space, and agreed that the technology demonstrated by the Vostok flights is a "base for military potential."

Dryden said his information indicates Russia did what it announced was done, but he said he had no information on whether the Vostoks adjusted orbits or had on-board propulsion systems. The mission, he said, "does not mean Russia is ahead of us in all ways."

He said he does not believe that the Soviet manned space flight program is being "vigorously pushed," because the Vostoks 3 and 4 were the first manned shots in more than a year.

With unlimited funds, Webb said, NASA could speed the U.S. program by conducting parallel developments, primarily in hydrogen-fueled upper stages for Saturn launch vehicles. He estimated that a crash program would cost about $6 billion annually, as compared with the $3.9 billion Fiscal 1963 budget for what he called a "fast-paced" space program.

Dr. Robert C. Seamans, Jr., associate NASA administrator, said the real significance of the Vostok mission was Russia's ability to launch two vehicles within 24 hr. where they wanted to launch them. He said the guidance accuracy demonstrated is no better than that in the Mercury manned orbital flights. Both Mercurys were launched on a 32.5-deg. plane with apogee and perigee within a few miles of the same figures for each shot.

Another NASA official pointed out the advanced countdown technique demonstrated by the launch of Vostok 4 in a firing window of less than 15 min. duration. He said ground checkout and fueling of the two launch vehicles must have been accomplished simultaneously.

If Vostok 4 was launched into the same orbit as Vostok 3, the rendezvous maneuver was a straightforward problem, he said. But if Vostok 4 made a change of orbital plane after launch, it would indicate a tremendous advance over the U.S. capability, he said.

The flight itself was a source of encouragement to the U.S. in terms of the coming six-orbit mission scheduled for Cdr. Walter M. Schirra in Mercury.

U.S.-USSR Space Comparisons

Washington—Soviet Union's launching of Vostoks 3 and 4 demonstrated a capability to conduct manned spacecraft rendezvous experiments that the U.S. had not planned to attempt until mid 1964, when a two-man Gemini capsule will try to dock with an unmanned Agena B vehicle. Soviet booster and spacecraft capabilities demonstrated by the Vostok flights, compared with U.S. capabilities in the same areas, are:

- **Launch vehicle**—Before Russia began launching the Cosmos scientific satellite series last March, Western observers estimated the thrust of Soviet space boosters at anywhere from 600,000 lb. to 1 million lb. Payloads put into earth orbit before the Cosmos series began included the five-ton Vostoks 1 and 2 and the seven-ton vehicle which launched a probe from earth orbit toward the planet Venus.

  Russia apparently used a new booster for the Cosmos series. Although there have been reports that it was smaller than earlier boosters, Aviation Week has learned that the Cosmos satellites actually were almost as large as Vostoks 1 and 2. Russia has never commented on the weight of Cosmos satellites. By late last week, Russia had revealed no weight figures for Vostoks 3 and 4, but one estimate was eight and one-half tons.

  First U.S. booster that will be in the 1 million lb. thrust class is the Saturn C-1. Although the first stage has made two test flights, the initial flight test of the second stage will not be made until sometime in 1963 and the two-stage combination probably will not be ready to orbit heavy payloads until 1964.
- **Spacecraft**—Vostoks 1 and 2 were in the five-ton weight class and Russia said they carried life support systems with lifetimes of 10 days. Vostoks 3 and 4 may be even larger, and Vostok 3 demonstrated a life support lifetime of four days and nights.

  One-man Mercury capsules weigh about 4,200 lb. Those used in the first two U.S. flights had life support systems with lifetimes of 18 hr. Those to be used for one day flights will have systems with a lifetime of 48 hr., to provide a safety margin.

  Two-man Gemini capsules will weigh 6,600-7,700 lb. and eventually will have a life support system that will permit two week missions. First flights are due in 1964. Apollo will be able to support three men for 10 days. Manned Apollo capsules will be tested in earth orbit about 1966.

Atlas 8, this official said. For the first time, NASA will depend largely on ships for tracking—a technique which apparently was successful in the Vostok flights.

Although the general consensus in Washington is that the military services now have the best argument for a larger space role that they have ever had, two high Pentagon officials, speaking at the seventh annual ballistic missile and space technology symposium at the Air Force Academy, did not reflect this view.

Gilpatric said he does not think the Russian feat "will change the weight or emphasis of our own program," which he described as "very sound."

Joseph V. Charyk, Undersecretary of the Air Force, cautioned against an over optimism on military space capabilities and "elaborate systems for doing military tasks in more expensive ways."

He said, however, that the military must not be constrained by a requirement to justify an operational system before money is approved. In military space programs, he said, "we must develop capabilities . . . to react promptly and effectively even though the particular challenge might not be considered a matter of decisive military importance."

In his talk, which was the keynote at the symposium, Gilpatric said the "Russian passion for secrecy" is preventing successful negotiations on disarmament. He did not mention the secrecy imposed on U.S. military space launches but said in relation to Russia's approach that secrecy has the unavoidable effect of increasing tension in the arms race, and so adding to the risk of war."

The flight plan of Vostoks 3 and 4 is being interpreted as the first step by Soviet Russia toward creation of a multi-manned space station for scientific and military use and an indication that Russia has selected the earth orbit rendezvous technique for landing men on the moon.

Vostok 3, piloted by Maj. Andrian Grigoryevich Nikolayev, was launched at 4:30 a.m. EDT Aug. 11 from the Baikonur launch complex in Kazakhstan and landed after 64 orbits at 2:55 a.m. EDT Aug. 15. The cosmonaut traveled 1,615,600 mi. and spent 94 hr., 25 min. in space flight.

Lt. Col. Pavel Romanovich Popovich was pilot of Vostok 4, launched at 4:02 a.m. EDT on Aug. 12 from the same site. He landed 6 min. after Nikolayev at 3:01 a.m. Aug. 15 after traveling 1,243,000 mi. in 48 orbits and 71 hr. of space flight.

The Russian news agency Tass said both pilots came down in their spacecraft in the same area, 373 mi. east of the launch site near the town of Karaganda.

The two spacecraft were in dual flight nearly 71 hr., with the stated objective of assessing the performance and reactions of two pilots subjected to identical stresses. Government and industrial officials in the U.S. believe the matching, precise orbits achieved by the Vostoks was no accident and that Russia attempted rendezvous and docking soon after Vostok 4 was launched.

Flight program reported by Tass included pilot tasks of maneuvering and controlling the Vostoks, lunar photography, eating, communication and movement in the pressure vessel.

Physiological measurements were made of:

- **Nystagmus**, the rapid and involuntary oscillation of the eyes associated with vertigo. In this experiment, Nikolayev was the test subject. Silver electrodes were installed on the outer corners of both eyes; movements to the right were recorded as positive pulses, and to the left as negative pulses.

A U.S. bioastronautics specialist told Aviation Week that Russia's desire to make this measurement indicates that the nausea of Maj. Gherman Titov in Vostok 2 was severe (AW Mar. 12, p. 114), or that Soviet Vostoks are stabilized by a slow but constant roll.

- **Respiration**, registered by a carbon pickup consisting of a thin rubber tube filled with carbon powder and fitted around the chest. Resistance increased as the tube expanded when the pilots inhaled, and decreased when they exhaled. Tass said respiration rate of both pilots varied between 15 and 19 breaths per minute.
- **Brain activity**, by use of an electroencephalograph employing electrodes on the front and back of the head. Device was used to record patterns of consciousness, alertness, fatigue and depth of sleep.
- **Heart activity**, with an electrocardiogram. Electrodes were attached along the armpit lines to the fifth rib.
- **Skin reaction**, by electrodes on the left foot and right shin. Measurements were made of response of the skin to flight stresses.

Nikolayev's pulse rate was reported as ranging from 64 to 72. Popovich's reached a peak of 104 at liftoff, but stabilized at 60 to 72 during the flight, Tass said.

Shortly after launch, Vostok 3 orbital elements were given as apogee, 156.02 mi., perigee, 113.76 mi., period, 88.5 min., and inclination to the equator, 65 deg. Transmission frequencies were listed as 20.006 mc. and 143.625 mc., with the tracking beacon operating on 19.995 mc. After a precise orbit was calculated following one complete orbit, the apogee was changed to 147.81 mi., perigee, 111.85 mi., and inclination, 64.59 deg. Period was 88.32 min. Russia reported these highlights of the flight:

- **Aug. 11**—Cabin temperature of Vostok 3 was 75F. Lunch, rest for one hour, conversation with Premier Nikita Khrushchev. Pulse readings varied from 78 to 92 at launching, and respiration varied from 12 to 20. After another 4.5 hr. Nikolayev reported visual observations of islands, rivers, lakes and cities. After 7 orbits, cabin temperature was 72F, pressure was 16.17 psi., and humidity 70%.
- **Aug. 12**—Nikolayev slept 7 hr. Cabin temperature was 62F, apogee was 143.54 mi., perigee, 111.23 mi., and period, 88.28 min. Vostok 4 was launched "to obtain experimental data on the possibility of establishing contact between two ships, coordinating the actions of the pilot cosmonauts, and checking the influence of identical conditions of a space flight on the human organism."

Initial Vostok 4 elements were given as a 160.24 mi. apogee, 111.85 mi. perigee, and 88.5 min. period. Two-way radio communications established between Vostoks 3 and 4 during the first orbit of Vostok 4. Live television images of the two were transmitted to Moscow. Pulse rates varied between 65 and 70. Vostok 3 cabin temperature was 62F, and Vostok 4 was 75F.

At 3 p.m. EDT orbital elements of Vostok 3 and 4, respectively, were periods, 88.2 and 88.3 min.; apogees identical at 141.41 mi., and perigees, 109.8 and 110.55 mi. Nikolayev slept 7.5 hr. and Popovich, 7 hr.

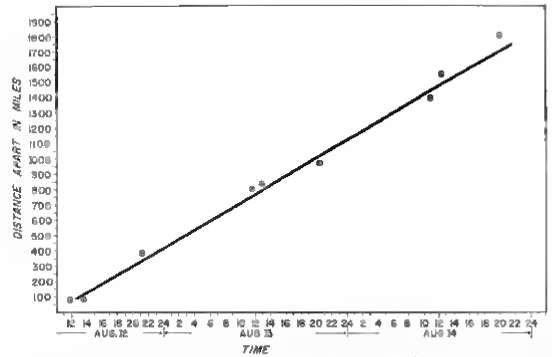
- **Aug. 13**—Pulse rates of both pilots averaged 60 during sleep. On awakening, they ate and spent the morning making scientific observations and taking unspecified physiological, vestibular and psychological tests. Pulse rates of both pilots varied between 60-65. Temperature in both cabins varied between 60F and 65F. Live television broadcasts were made to Central Television Service and Intervision. Prof. Aleksandr Myasnikov, a cardiologist, reported no disturbances of the heart of either pilot.

Menu of the two astronauts consisted of bite-sized pieces of cutlets, veal, chicken, pies and sandwiches, with fruit, coffee, water, fruit juice and semi-solid food in tubes.

- **Aug. 14**—Both pilots slept 7 hr., exercised on awakening and ate. Both reported no ill effects after 46 orbits by Nikolayev and 30 by Popovich. Environments in both spacecraft showed no significant changes.

Russia reported no details of preparations for re-entry, or the stresses the pilots underwent during launch and re-entry. Tass said the pilots crawled from their capsules after they landed near Karaganda "according to plan." First Soviet space pilot, Yuri Gagarin, came down with his spacecraft but Major Titov ejected himself and landed in a personal parachute.

TELEVISION screen photographs of Russian Cosmonaut Andrian Nikolayev in his orbiting capsule Aug. 12 (top), Aug. 13 (center) and Aug. 14 (below) show signs of growing fatigue. Retouching above eyelids (center) may hide eye movement sensors.



SOHIO TRACKING PLOT of separation of Vostok 4 from Vostok 3 indicates a steady progression. Dispersion of fixes—the dots—about assumed line is considered normal. Vostok 4 had completed six orbits before first fix at noon Aug. 12 and capsules were out of range of Sohio tracking for long intervals—from 10 p.m. Aug. 12 until 11 a.m. Aug. 13, for example.

Sohio Tracks Vostoks Over U.S.

First tracking fixes on both Vostok 3 and 4 by the Sohio Research Center in Cleveland, Ohio, about noon EST Aug. 12 placed the two capsules about 75 mi. apart and in virtually identical orbital planes.

Subsequent fixes by Sohio, a private center sponsored by the Standard Oil Co., showed the two spacecraft separated gradually to a distance of 1,793 mi. at the last fix Aug. 14.

Sohio used passive Doppler radio antennas to follow the signals transmitted by each spacecraft's tracking beacon. Vostok 3 transmitted on a frequency of 19.996 mc. and Vostok 4 on 19.990 mc. Both spacecraft used 20.006 and 143.625 mc. for space-to-ground transmissions.

Sohio's first track of the two Vostoks occurred at 10:22 a.m. EST Aug. 12, but because the spacecraft were beyond the horizon, the center picked up only scattered transmissions. These signals proved to be unresolvable.

First good sighting came an hour and a half later when Vostok 3, then in its twenty-second orbit, and Vostok 4, then in its sixth orbit, flew southwest to northeast across the eastern seaboard of the U.S. Vostok 3 came over the horizon at 11:54:56 a.m. EST followed 12-15 sec. later by Vostok 4. Both spacecraft were in almost identical orbital planes and were at an angle of about 22 deg. above the horizon and approximately 281 mi. slant-range from Cleveland. Bearing, a line drawn from the center at Cleveland perpendicular to the orbital plane of Vostok 3, was 120.5 deg. Lt. Col. Pavel R. Popovich then trailed Maj. Andrian G. Nikolayev in Vostok 3 by about 75 mi.

Subsequent observations follow. First time is Vostok 3, the second Vostok 4. Bearings in the 270-360 deg. and 90-180 deg. quadrants indicate the capsules were traveling southwest to northeast; those in the 0-90 deg. and 180-270 deg. sectors, northwest to southeast.

- **1:25:27 and 1:26:12 p.m.** EST Aug. 12. Bearing 316 deg., angle above the horizon 4.2 deg. and slant range 706 mi. Distance between the two spacecraft still was about 75 mi.
- **9:05:48 and 9:07:11 p.m.** EST Aug. 12. Bearing 40.4 deg., angle 1.7 deg., slant range 850 mi., separation 385 mi.
- **11:25:30 and 11:28:15 a.m.** EST Aug. 13. Bearing 119.9 deg., angle 18.6 deg. and slant range 321 mi. Vostok 4 now trailed Vostok 3 by 800 mi.
- **12:56:23 and 12:59:15 p.m.** EST Aug. 13. Bearing 315.7 deg., angle 5.0 deg., slant range 669 mi., and separation 831 mi.
- **8:36:14 and 8:39:31 p.m.** EST Aug. 13. Bearing 53.6 deg., angle 38.3 deg. and slant range 180 mi., separation approximately 970 mi.
- **10:54:56 and 10:59:36 a.m.** EST Aug. 14. Bearing 115.2 deg., angle about 5.0 deg. and slant range 670 mi., separation 1,382 mi.
- **12:25:00 and 12:30:18 p.m.** EST Aug. 14. Bearing 310.0 deg., angle 15.4 deg., slant range 370 mi., separation 1,545 mi.
- **8:04:25 and 8:10:31 p.m.** EST Aug. 14. Bearing 51.0 deg., angle 18.7 deg., slant range 319 mi., separation 1,793 mi.

Time lag between the two vehicles at Sohio's last reading was a little more than 6 min., which corresponds to the time differential reported by the Soviets in the landings of the two Vostoks on Aug. 15. Sohio also estimated that perigee points of both spacecraft differed by less than three vertical miles.

Vostok 3 was launched into an orbital plane inclined 64 deg. 59 min. to the equator. It took 16 orbits and nearly 24 hr. before Nikolayev's spacecraft again flew over the launch area in the same inclination in which it had been launched.

Extrapolating backward from its tracking data, Sohio estimated that Vostoks 3 and 4 were close enough to each other for rendezvous only during the first five orbits of Vostok 4.

Britain's Jodrell Bank station reported failures in both radar and radio telescope equipment Aug. 12 and 13, but obtained three radio fixes Aug. 14 which generally agreed with Sohio data.

TV SCREEN photograph of Lt. Col. Pavel Popovich in Vostok 4 was made Aug. 12.

Sen. Cannon Presses for Space Deterrent

By George C. Wilson

Washington—Sen. Howard W. Cannon (D.-Nev.) is pressing the Kennedy Administration to extend the deterrent principle of the Strategic Air Command by building a military force which can operate in space.

In a speech prepared for delivery today, Sen. Cannon said the flights of Vostok 3 and 4 provide "stark evidence" that Soviet Russia is advancing toward its goal of "attaining military dominance in the near-earth space envelope." He said "to believe that space will be maintained for peaceful purposes in the absence of a U.S. deterrent space capability is a wholly fallacious and fearsome misconception."

Sen. Cannon is a member of the Senate Aeronautical and Space Sciences Committee and of the Armed Services Committee, both of which help shape U.S. space policy. His speech will serve as a trial balloon for those within the Kennedy Administration who fear that any enlargement of the military space role will meet with an adverse public reaction.

Although Sen. Cannon is a brigadier general in the Air Force Reserve and could be expected to have a military bias, his speech is of extraordinary interest because it was written in consultation with many civilian and military officials within the Administration and therefore articulates the viewpoint of those pressing for a larger military space role.

Sen. Cannon told AVIATION WEEK he wants to push the question of the military's space role before the public so it can be debated openly. "As it is now," he said, "everybody is afraid to talk about it." He said he plans a series of speeches on the military space role and said that today's speech has been in preparation for a month. The resulting discussion may lead eventually to the appointment of a special military space subcommittee of the Senate Armed Services Committee, although Chairman Richard B. Russell (D.-Ga.) said there was no immediate prospect of this.

The National Aeronautics and Space Administration cannot be relied upon to provide all the technology the military needs for space capability, Sen. Cannon said. He said the requirements for peaceful and military operations in space are radically different, and said "the present direction of our national efforts in space gives little or no assurance that attention is truly directed to the development of our military capabilities."

Sen. Cannon quoted from speeches by President Kennedy and Vice President Lyndon B. Johnson in an attempt to show that they realize that military requirements in space must be fulfilled. He said it was time to "formulate and announce a U.S. declaration not only of 'space for peace' but [it] should include 'space for insuring national security'."

Such a declaration "would remove the inhibitions under which the Department of Defense is now laboring and allow them to identify and establish the necessary broad goals within which the military can develop both near-term space systems and the technology for the future," Sen. Cannon said.

Air Force leaders have been complaining privately that they have been severely restricted in what they can say about their military space ambitions since last June, when published reports claimed that the Air Force planned to expand its space role. President Kennedy said last June 14 that in the national space program, "the military have an important and significant role, though the primary responsibility is held by NASA, and it is primarily peace, and I think the proportion of that mix should continue."

The type of new space policy declaration Sen. Cannon is requesting already has been drafted by the staff of the National Aeronautics and Space Council, headed by Vice President Johnson. But the draft statement was put on the backburner after the recent flare-up over the military's space role (AW June 18, p. 26; June 25, p. 34).

Sen. Cannon tried to justify such a change by declaring that "no truer words have ever been spoken" than President Kennedy's 1960 campaign statement:

"If the Soviets control space, they can control the earth. . . . The U.S. must have pre-eminence in security as an umbrella under which we can explore and develop space for the benefit of all mankind."

President Kennedy was given a copy of Sen. Cannon's speech in advance of its delivery but did not approve or disapprove it, the senator said.

Specifically, Sen. Cannon recommended the development of military offensive as well as defensive space vehicles. "The military forces of the U.S. must be able to exploit space in every way by which their military missions can be more effectively performed," he said. Sen. Cannon also said the Space Detection and Tracking System (SPADATS) should be expanded, an orbital space test station for the military should be developed, and the military's bioastronautics program accelerated.

In contrast to Sen. Cannon's views, Sen. Russell and Chairman George P. Miller (D.-Calif.) of the House Science and Astronautics committee said they saw no immediate need for realigning the military-NASA relationships.

Sen. Russell told AVIATION WEEK that military programs probably were transferred to NASA too quickly. "But it is too late to go back and unravel it all now." He said nothing more could be done in space militarily without burdening the nation "with flagrant waste." The Russian achievements with Vostok 3 and 4 "are embarrassing, if not humiliating" but the U.S. has little choice but to keep pursuing its present course, Sen. Russell said.

F-105s Grounded for Repairs, Modification

Air Force is putting its early production Republic F-105 attack fighters which have been grounded for the past two months, through a preventive maintenance and modification program. About 1,800 man-hours of labor is going into each aircraft.

Tactical Air Command earlier this year noted that hydraulic lines and wire bundles were chafing resulting in occasional failures. On June 20, TAC restricted flight of its early production aircraft to operational emergency use only. Air Force explanation is that regular maintenance personnel have been diverted to the modification and repair project in order to complete it as soon as possible.

Correction of the chafing defect requires making major openings in the fuselage through flush riveted skin. Because of this it was decided to combine it with a modification program which includes incorporation of a guidance system for Bullpup air-to-surface missiles, provisions for carrying and delivering conventional high explosive bombs, napalm tanks and rockets and other changes developed since production of the aircraft began.

New production aircraft now being delivered from the Republic factory have the modifications and fixes already incorporated. Work for the program, called "Project Look Alike," is being performed at Brookley AFB, Mobile, Ala. Site of the Air Material Area for the F-105, Seymour Johnson AFB, Goldsboro, N.C., and Nellis AFB, Las Vegas, Nev. The project is expected to be completed before the end of the year.

FULL SCALE MOCK UP of the General Electric Ryan VZ-11 V/STOL aircraft sits in Ryan plant at San Diego, Calif. The two-seat aircraft, under development for the Army, is scheduled to make its first flight in mid-1963. It is powered by two GE J85 engines.

VZ-11 Component Production Flow Begins

By Russell Hawkes

San Diego, Calif.—Major components manufacturing for the General Electric-Ryan fan-in-wing VZ-11 V/STOL research aircraft for Army has begun, and a full-scale mockup has been built at the Ryan Aeronautical Co. plant here.

First flight is scheduled for mid-June, 1963. Meanwhile, a new round of wind tunnel tests for the GE lift-fan propulsion system will begin next month at National Aeronautics and Space Administration's Ames Research Center and for the first time will include tests of the nose-fan.

System tested will be an advanced version with more compact ducting and lighter components than the original engines.

The VZ-11 is designed to fly with the original engine to avoid delays in the schedule due to any new engine development problems that may occur.

Fan-in-wing concept is expected to enable aircraft designers to select engine size for maximum cruise efficiency and still obtain a vertical lifting thrust-to-weight ratio high enough to permit vertical takeoff and hovering flight. The VZ-11 has a thrust-to-weight ratio of 1.2 at an altitude of 2,400 ft. and a temperature of 94F. The GE-Ryan design obtains a threefold increase in effective thrust for the hovering or vertical takeoff condition by using the energy in the propulsive gas flow to drive a pair of large lift-fans embedded in the wings and a small one in the nose.

Two GE J85 engines develop a total of 5,316 lb. static thrust in the cruise configuration with exhaust gases emitted straight out the tailpipe. With exhaust gases diverted to drive the lift-fans, the system develops a total of 13,946 lb. of lifting thrust. When the diverter valves are in the lift-fan position, the tailpipes are blocked off and exhaust gases from each engine are directed downward into a three-way cross-over duct. Each engine supplies half the hot gas to drive each lift-fan so that even if one engine fails the fans will continue to deliver a balanced lifting thrust to permit a safe landing.

Hot exhaust gases from the two engines pass into scroll ducts around each lift fan (AW Aug. 8, 1960, p. 94). In the scrolls they are directed against tip turbine blades on the perimeter of each lift-fan to deliver engine power to the fans. Total duct losses are little more than 10%, according to GE engineers. To achieve this, gas flow is held below Mach .35 in the ducts.

General Electric is involved in a design improvement program for the lift-fan. An important goal in this will be a reduction in the vertical dimension of the diverter ducts to permit aircraft to be designed with shallower fuselages than that of the high-sided VZ-11. Another improvement will be a flattening of the tip turbine scroll duct so that fans can be set within thinner wings.

Ryan has designed wings with a thickness ratio of only 5% which are supposed to accommodate lift-fan installations. The wing of the VZ-11 is much thicker and has a somewhat unusual shape because of the large fan bearings and the thick scrolls.

From top to bottom, the lift-fan structure, excluding any ducting, consists of five superimposed components: large butterfly doors, a front frame, the rotor, a rear frame and stator, and the exit louvers. The butterfly doors close over the fan during cruising flight to give the wing a reasonably smooth upper surface.

When the doors are opened, the hole they leave in the wing reduces air foil lift by 25%.

Front frame is the structure that bears the thrust of the lift fan to the airframe. It is circular with a fore-and-aft beam running through its center. The rotor bearings are located in the middle of the beam within a hemispherical housing. Part of the GE improvement program for the fan is a sharp reduction in the size of this housing to minimize its interference with inflow of air and make possible a smoother wing. A circular vane to control air in flow at the edge of the fan is also a part of the front frame area.

Rotor consists of a fan with 36 blades which are joined at the tips by a solid ring. On the outer surface of the ring are turbine blades whose tips are joined by another solid ring. Fan blades for the first VZ-11 wing installations will be solid but improved fans will have hollow blades to cut weight. The first installations of the nose fan will have hollow blades since it was designed later than the wing fan.

Stator is immediately below the rotor and consists of radial flow-straightening vanes. The exit louvers, when closed, form part of the lower wing skin. When open, they are the means of controlling the motion of the airplane in roll and yaw and are used to vary the amount of lifting thrust.

Nose Fan

Nose-fan is similar to the wing fans except that the exit louvers of the wing fans are replaced by large curved thrust reverser panels which are used to modulate effective nose-fan thrust and thus control pitch attitude of the airplane. Inlet doors on top of the nose are narrow louvers which do not restrict pilot visibility.

Cockpit controls of the VZ-11 are conventional and the pilot need not move his hands to different controls during transition between vertical and horizontal flight. A lift control lever like the collective pitch control of a helicopter is the only basic control which would be unfamiliar to a fixed-wing pilot. All control power is supplied by the three fans during vertical flight. Control feel is provided by springs during vertical flight but gradually is replaced as the airplane accelerates into horizontal flight and the controls acquire feel from aerodynamic forces.

Complicated mechanical mixer automatically coordinates airfoil controls and fan controls and trims the airplane during transition. The airfoil controls are conventional rudder, elevator and ailerons. Fan controls are the exit louvers of the wing fans and the reverser of the nose-fan.

In cruising flight the nose-fan reverser panels close to form a smooth part of the nose skin. When open, they divide the air stream from the fan. The air passing between the panels is not deflected and applies an upward thrust to the nose. The air that passes outside the panels is deflected outward and up to apply a downward thrust to the nose. The position of the panels is modulated by the fore-and-aft movement of the pilot's control stick and the airplane is made to pitch downward or upward. The maximum upward thrust is 300 lb. and the maximum downward thrust is 80 lb. The nose-fan tip turbine uses 10.5% of the exhaust from the two J85 gas generators.

Wing fan exit louvers are angled in opposite directions when the lift control lever is down. This chokes the air stream from the fans and reduces the effective thrust of the fans. When the pilot raises the lift control, the louvers move toward a vertical alignment and effective thrust increases. When it exceeds the weight of the airplane, the airplane will rise vertically. To descend, the lift control is lowered until effective thrust is less than the weight of the airplane. A twist-throttle is on the handle of the lift control so the pilot can coordinate power setting and louver position.

To roll the airplane, the pilot chokes one fan more and the other less by moving his control stick to right or left. When the pilot depresses a rudder pedal the louvers on one wing deflect the air stream forward and those on the other wing deflect it aft causing the airplane to yaw.

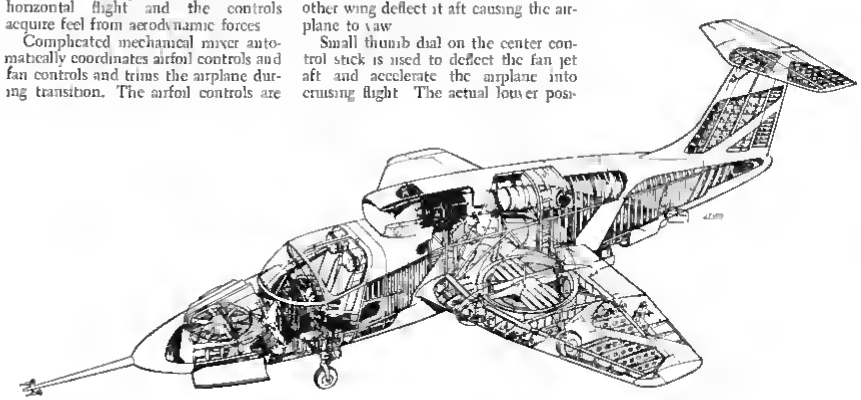
Small thumb dial on the center control stick is used to deflect the fan jet aft and accelerate the airplane into cruising flight. The actual louver positions during vertical flight are the net result of these control operations after they have been coordinated by the mixer.

The louvers are operated by tandem hydraulic actuators so that there must be two failures before actuation fails. To prevent loss of hydraulic pressure because of an engine failure, there is a pump on each J85 engine. An automatic stability augmentation system operates through a separate electro-mechanical control loop which has only 25% of the authority of the pilot-operated controls. Wing fans counter-rotate to cancel gyroscopic forces.

J85 Positions

Two J85 gas generators are mounted above the fuselage of the VZ-11 to avoid ingestion of hot exhaust gas and foreign objects blown into the air by the blast of the fans. The engine air inlet is located far enough aft to permit the pilot to use an ejection seat.

Thrust spoilers are mounted on the fuselage just aft of the tailpipe exits. In transition from the cruising mode to vertical mode preparatory to landing, the pilot can open the thrust spoilers and run his engines up to military rated power before switching the diverter valve to the fan position. This shortens the time required to spin the fans up to speed. This is desirable because of the big loss of lift when the butterfly doors open. With engines at idle power, spinup takes 4.5 sec. When they are already at military rated power, the time is reduced to 2.5 sec. The response time of the diverter valve is 0.5 sec. All doors, louvers, and the reverser are repositioned simultaneously with the diverter valve.



CUTAWAY DRAWING of the VZ-11 shows wing and nose fans, J85 engines and details of fuselage construction. Note louvers over fans.

New Orders May Ease Blue Water Loss

By Herbert J. Coleman

London—British missile policy, as defined by the government, last week appeared to be turning toward design and production of smaller weapons after abandonment of the country's only large surface-to-surface nuclear missile, the English Electric Blue Water (AW Aug 6, p 31).

Cancellation, announced by new Minister of Defense Peter Thorneycroft shortly after the British Parliament recessed until October, contained, however, a few bright spots for the industry in general. They were:

- **Additional order** for six Vickers VC 10 four-jet transports for Royal Air Force Transport Command to augment a fleet of five VC 10s ordered last year (AW Sept 11, 1961, p 37). Thorneycroft said portions of the planes will be built by Short Brothers & Harland at Belfast under subcontract, but Vickers-Armstrongs has not yet been informed of the precise hardware involved.
- **Development contract** to Hawker Siddeley Group for a small shipborne anti-aircraft missile designated CF-299, a new generation weapon to succeed the Short Seacat now in service with the Royal Navy.
- **Development of Swingfire** anti-tank missile by British Aircraft Corp. from the weapon originally designed by Fairey Aviation (AW Jan 8, p 25). The weapon will succeed the Australian Malkara missile, and English Electric will do the work.
- **Further work** on Bristol Bloodhound 2 armed, according to the Ministry of Defense, at developing a third-generation large surface-to-air weapon which could be used by all three services.

In addition, the Ministry placed an order for a third nuclear submarine from Vickers, Ltd., and also said it would buy 1,000 Trojan personnel weapon carriers for the British army.

In the meantime, the Ministry said development work will continue on the Avro Blue Steel standoff bomb and on the British Aircraft Corp. tactical strike fighter, the supersonic TSR 2, which will fly next year. Preproduction order is for 10 airplanes.

Cancellation of Blue Water touched off an immediate storm of protests by individual members of Parliament and labor unions representing an estimated 2,000 English Electric missile workers at Stevenage who will be laid off starting this week.

Thorneycroft justified his decision to cancel the weapon after spending about $60 million in development by referring to it as a "necessarily expensive project [in which] . . . hopes that this weapon would be adopted and purchased by other NATO countries have not been realized." Dropping Blue Water, he continued, would allow the Ministry to press plans for significant improvements in mobility and conventional firepower of the British army.

The move means that the British army will not have immediate control of a ground-launched nuclear weapon, an interpretation backed up by Thorneycroft's renewed backing of continued development of the Royal Air Force nuclear strike capability.

Money will continue to go into the Avro Blue Steel standoff bomb project until the Douglas Skybolt comes into service to replace it.

He also stressed that the TSR.2 will be available in the nuclear role to support the British army, a view not shared in army command circles where the emphasis on airborne weapons has shifted strongly toward the VTOL role, particularly regarding the Hawker P.1154 strike fighter being considered by NATO and which will go into production for Royal Air Force (AW July 23, p 27).

Two other factors were behind the cancellation of Blue Water:

- **British defense budget** is rising beyond the limit of 7% of the gross national product set by the 1962 Defense White Paper (AW Feb 26, p 36). The White Paper placed the budget for 1962-63 at $4.8 billion, but rising development costs, particularly in Blue Steel (AW Feb. 12, p 34) and Blue Water, threatened to push it well beyond acceptable limits.
- **Revised American concept** of conventional weapons for NATO ground forces, as backed by Defense Secretary Robert McNamara, a philosophy that found little favor with Thorneycroft's immediate predecessor, Harold Watkinson.

Strength of U.S. missiles in foreign markets was another contributing point.

In the past decade, the only British weapons that have had a wide sale are the Hawker Hunter jet fighter and the Bristol Bloodhound missile. The rest of Britain's armory, such as the V-bomber fleet and English Electric Lightning, have apparently been designed with little regard for export potential, and the country has had no success in selling them, even to Commonwealth countries.

Thorneycroft is a confirmed believer in joining with European governments and industrial firms in forming cooperative consortia to build weapons and transports, and has been a prime mover in pushing the de Havilland Blue Streak as a space launcher and in building a supersonic transport in cooperation with the French.

This philosophy, to which he is admittedly committed, may have considerable bearing on eventual selection of a tactical V/STOL transport for the Royal Air Force.

Thorneycroft last week said the RAF operational requirement decision, already long overdue (AW Aug. 6, p 26), will be reviewed in October. He has privately shown considerable interest in the NATO BMR-4 tactical transport competition because of the possibility of wide United Kingdom participation in construction.

In a reference to the economic health of the British aircraft and missile industry, Thorneycroft claimed the government this year is spending $900 million on the industry, although he said that the Blue Water decision would be a severe blow to BAC and the English Electric employes at Stevenage.

With Blue Water gone, BAC defense work now is concentrated on Bloodhound 2, Thunderbird 2, the Vigilant anti-tank missile and Lightning fighter, all in production, and the TSR-2 supersonic fighter preproduction order.

Defense work by Hawker Siddeley Group includes the Avro 748 and Armstrong Whitworth Argosy turboprop transports, the Folland Gnat trainer, Hawker Hunter two-seater conversions, the Avro Vulcan V-bomber, and the Blackburn Buccaneer Navy fighter, all in production.

Blue Water Uproar

London—Initial parliamentary reaction to cancellation of the Blue Water missile was sharp and immediate and gave some indication of what Defense Minister Peter Thorneycroft will face when the House of Commons reconvenes in October.

George Brown, deputy leader of the opposition Labor Party, said the government has made "the most costly and calamitous defense muddle ever . . . the tragic aspect is the fact that despite 11 years of effort under nine successive ministers, during which we have spent more than $45 billion, Britain is still without any coherent defense policy or weapons program, or even a basic agreement with our allies."

A member of Thorneycroft's party, Martin Hadden, called the cancellation "hasty, ill thought-out and a shabby reward for the finest electronic and missile building team in Western Europe." He accused the minister of lack of planning to keep the missile team intact.

Army Lockheed VZ-10 turbojet VTOL testbed, shown on its first flight, is powered by two Pratt & Whitney JT12A-3 engines.

Lockheed VZ-10 Begins Flight Evaluations

Ejector fairings for hovering flight are visible on top of fuselage. Bulbous cockpit is designed for maximum visibility. Nose-high attitude is evident during landing, below.

Army/Lockheed VZ-10 VTOL testbed made its first flight recently at Lockheed's Marietta, Ga., facility, but did not operate in the hovering regime.

First phase of the aircraft's flight test program, due to be completed in October, will test and evaluate the aerodynamic and handling features of the VZ-10. The aircraft, nicknamed the Hummingbird after the bird whose flying characteristics it was designed to imitate, uses a system of augmented ejector mixing chambers in the fuselage to divert engine thrust and achieve hovering flight.

System diverts exhaust gases from the two Pratt & Whitney JT12A-3 engines to ejector ducts where the flow is augmented by air pulled in from above the fuselage. VZ-10 has fairings above and below the center fuselage which cover the ejector duct system when the aircraft is in forward flight (AW Dec. 11, 1961, p 30).

Top speed of the VZ-10 is expected to be approximately 520 mph., and the aircraft will have a service ceiling of approximately 40,000 ft., fixed by cabin pressurization limits (AW Feb. 5, p 23). Crew is housed in a bulbous cockpit with side-by-side seating to provide maximum visibility.

The Hummingbird, which can cruise on one engine for economy, has a gross weight of 7,200 lb. Wingspan is 25 ft. 8 in., length is 32 ft. 8 in. and wing area is 104 sq. ft.

Army to Use Individual Project Managers

By Katherine Johnsen

Washington—Individual project management, initially tried by Navy with the nuclear submarine program under Vice Adm. Hyman Rickover, will be the key feature of Army's new approach to weapons research-development procurement under its newly created Materiel Command (AW Aug. 6, p. 36), Finn J. Larsen, assistant secretary of the Army for research and development, told the House military operations subcommittee last week.

Twenty-nine projects have already been selected for management by individual project managers who will report directly to the commanding general of the Army Materiel Command (AMC) and whose activities will cut across the AMC subcommand structure. These projects were selected on the basis of their large dollar value or critical features, Larsen said. Among them is Army's field ballistic missile program, still in the study phase.

The new approach is similar to Air Force Systems Command's use of Systems Project Offices for the management of technical projects.

Larsen conceded that "it will take some period of time before the new Materiel Command is functioning effectively." It combines the functions which in the Air Force are divided between the Systems Command and the Logistics Command.

Eventually, about half of the total projects of AMC will be assigned to project managers, vertically organized and with the authority and responsibility to accomplish the objectives of their project, Larsen said.

Among the projects already designated for individual management are six aircraft programs: light observation helicopter, Mohawk reconnaissance aircraft, Caribou assault transport, Iroquois utility helicopter, Chinook heavy helicopter, aircraft weaponization. Management headquarters of these projects will be at AMC's headquarters in Washington, D. C.

The seven missile projects selected for individual management are: Nike Zeus anti-missile missile, Marshall (formerly Missile B), which will replace the Little John and Honest John tactical missiles; Pershing tactical ballistic missile; Sergeant short range ballistic missile; Mauler surface-to-surface missile, Hawk surface to air missile; and Hercules air defense missile. Managers of these projects will have headquarters at Army's electronics command at Ft. Monmouth, N. J.

In addition, the Advent communications satellite program and several drone and communications programs have been selected for individual project management.

Larsen explained the role of Army's project managers to the subcommittee, headed by Rep. Chet Holifield (D.-Calif.).

The project manager has a project staff assigned to his immediate office and responsible directly to him. This staff consists of technical personnel who can follow the main technical problems of the weapon—whether they be developmental or production—and who can initiate the technical development plan and management personnel who execute programing, budgeting, and financial management functions.

The project manager also controls the dollar resources allotted to his project. Funds for the 29 projects, regardless of whether they are research or development test and evaluation, or procurement funds, are alloted specifically for each project. They cannot be used by the commodity commander for other purposes without a program change, in which the project manager has an active voice. These funds, plus his authority over a specific project, permits the project manager to "buy" a substantial amount of support and assistance, both from in-house laboratories and installations and from outside contractors as well.

"Project managers are appointed by the commanding general, Army Materiel Command, and with respect to their project 'wear the commanding general's hat.' This gives them a red-line channel direct to the commanding general, Army Materiel Command, for emergency purposes."

In the case of Army procurements handled by Air Force or Navy, Larsen said, the Army project manager will control the funds used by the other services.

Army will perform technical evaluation and direction of its weapons systems with in-house personnel, Larsen told the subcommittee. One of the points of conflict in the Advent program, he said, was that Space Technology Laboratories, which has performed technical direction for Air Force on some project wanted to take over technical management from Army.

Research Analysis Corp., a nonprofit organization formed a year ago, will advise Army on operational needs under a five-year contract. In this role, RAC replaced the Operations Research Office administered by Johns Hopkins University.

RAC President Frank A. Parker, formerly an assistant to Defense Department's Director of Defense Research and Engineering, then Dr. Herbert York, said that RAC now has 430 personnel, including 170 professional personnel, and plans a 10% to 15% growth in the coming year. Its only contract is with Army.

Research by RAC-ORO, Parker told the subcommittee, played a major role in the decisions to develop tactical atomic weapons and nuclear reactors for supplying heat and electricity at remote Army installations in the Arctic and Greenland.

RAC's board of trustees consists of Dr. Hector Skifter, president, Airborne Instruments Laboratory, as chairman; Gen. Omar N. Bradley, chairman, Bulova Watch Co.; Dr. Hendrik Bode, vice president Bell Telephone Laboratories; John T. Connor, president, Merck & Co.; John Floberg, general counsel, Firestone Tire and Rubber Co.; and Parker.

As part of its broad program to develop and perfect its in-house technical capability, Larsen said that Army will shortly issue a statement of management policies for its research and development laboratories. It will cover these points:

- **Announcement that the laboratory** commander should delegate to the civilian technical director authority and responsibility for accomplishing the technical program and assign him a position in management that will command respect not only within the laboratory, but also within the scientific community.
- **Encouragement of advanced** education to strengthen both the technical and management competency of laboratory personnel.
- **Decentralization** of management and control to the maximum extent possible and still insure effective program execution.
- **Provision for stabilized** and uninterrupted tours for the technically qualified military officer at Army laboratories.

Larsen also noted that Army has established a program—and funded it with $10 milion for fiscal 1963—to provide laboratory directors with money for independent research or exploratory work which they consider promising.

A technical career service, providing for training and Army-wide promotional opportunities, is now being developed, Larsen reported.

Missile B Contracts

Chrysler Corp. and the Chance Vought Division of Ling-Temco-Vought will receive contracts totaling about $1 million for program definition studies on Army's Marshall tactical missile, formerly known as Missile B. Aerojet is associated with Chrysler for propulsion. The weapon is intended as a replacement for existing Honest John and Lacrosse surface-to-surface missiles. Army originally recommended three contractors, including General Electric, but Defense Department apparently decided to narrow the field (AW Aug. 6, p. 31).

Comsat Bill Outlook

Washington—Enactment of legislation setting up a privately financed corporation to develop and operate a communications satellite system appeared assured last week after a time limitation of 1 hr. per Senator was clamped on Senate debate.

The invoking of cloture, by a 63 to 27 vote, left some 15 determined opponents of the measure only 15 more hours of talking time.

Although they then turned to parliamentary tactics—quorum calls and roll calls on innumerable amendments—for further delay, both the Democratic and Republican Senate leadership were confident and determined to bring the measure to a vote and have it passed by an overwhelming majority.

The Senate rejected amendment after amendment without consideration of their merits. The objective was to pass a bill which could be accepted by the House without change. This would avert the need for further Senate action—and another talkathon.

X-15 Tests Inertial Pitch Angle Indicator

Pitch attitude of a winged re-entry vehicle can be controlled precisely by reference to the position of the inertial guidance system stable platform rather than by direct measurement of aerodynamic angle of attack, according to preliminary results of a flight test of the North American X-15 last week.

National Aeronautics and Space Administration test pilot Joseph A. Walker evaluated the technique in the No. 3 aircraft equipped with the Minneapolis-Honeywell adaptive flight control system. The test was made necessary by the fact that dynamic pressures at the altitudes now being reached by the X-15 are less than at the 250,000-ft. design altitude of the aircraft and are below the value specified by NASA for the design of the Nortronics Q-ball angle of attack sensor.

In all previous flights, pitch attitude was controlled by reference to the Q-ball but, at least in its present configuration, it does not function as well at extreme altitude as had been hoped. At the time Nortronics designed it, NASA specified that it need operate only to a maximum dynamic pressure of 1.0 psf. In his record flight to 314,000 ft., Maj. Robert M. White found the dynamic pressure to be about 0.6 psf.

Last week, Walker flew to an altitude of 197,000 ft. and said he could control the aircraft well by inertial measurement of pitch angle. The altitude goal of the flight had been 220,000 ft. It was not achieved because the thrust developed by the Thiokol XLR-99 rocket engine was 4,000 lb. less than its rating of 57,000 lb. The reason for this has not yet been determined. The thrust chamber pressure was 550 psi instead of 580 psi, as it should have been.

The roll damper in the control system failed during re-entry and Walker experienced a slight Dutch roll but he said it was not difficult to suppress. The X-15 reached a maximum speed of 3,784 mph. at an altitude of 142,000 ft. after an engine burn time of 83 sec., which was as programed in the flight plan.

Hearings on Nuclear Space Projects Set

Washington—Nuclear space projects, disarmament and the economic impact of defense will be investigated in congressional hearings in coming weeks.

Rep. Melvin Price (D.-Ill.), chairman of the research and development subcommittee of the Joint Committee on Atomic Energy, announced public hearings Sept. 5-7 on the Rover nuclear rocket program, the SNAP auxiliary nuclear power program and the Pluto nuclear ramjet missile program.

Price expressed concern that "the Atomic Energy Commission, National Aeronautics and Space Administration, and Defense Department still cannot agree on how to manage and coordinate the SNAP program." He called for a firm program for Pluto which would move toward "a discernible goal," and for an acceleration of the Rover program.

Senate Small Business Committee scheduled open hearings on defense spending in labor surplus areas Aug. 21 and 22. Sen. John Sparkman, (D.-Ala.), chairman of the committee, commented that "we want to learn whether defense spending can effectively be used as an instrument, through prime or subcontracts, to decrease unemployment, and in general, bolster the economy of distressed areas."

Senate Preparedness Investigating Subcommittee is planning a comprehensive series of hearings on arms control and disarmament which will focus on the basic importance of nuclear testing to national defense. They will probably start in about a month.

News Digest

Development of Titan 3 space booster for use with Dyna-Soar, communication satellites and satellite inspectors has been approved by Defense Secretary Robert S. McNamara and was expected to be announced late last week.

Government-guaranteed loans to buy cargo aircraft was authorized in legislation approved last week by the Senate Commerce Committee's aviation subcommittee. Maximum guarantee for an individual carrier was set at $15 million. Both Senate and House approved a five-year extension of the guaranteed loan authorization for local service carriers and raised the maximum for a carrier from $5 million to $10 million.

Union machinists formally ended their three-month strike against Republic Aviation Corp., Farmingdale, N. Y., last week when the men voted to accept a three-year contract. New contract provides for wage increases up to 23 cents an hour over three years, severance pay equal to $50 per seniority year up to a $500 maximum and fringe benefits, including work rule modifications.

Piper Aircraft Corp. has announced a new version of its low-wing four-place Cherokee, the Cherokee B. Aircraft has either a 150 hp. or 160 hp. Lycoming engine, new engine mount, carburetor heat system, muffler and a 35 amp. alternator replacing the standard generator. Top speed has been increased to 139 mph. in the 150 hp. version and 141 mph. in the 160 hp. version. Price remains the same as previous Cherokee models.

Two USAF Atlas D missiles were successfully launched within a few minutes of each other in Operation Pegboard at Vandenberg AFB, Calif., recently to demonstrate rapid fire capability of an Atlas launch complex. An Atlas F also was fired from its lift launcher but had to be destroyed by the range safety officer when it deviated from its planned trajectory about a minute after launch.

Gloster Whitworth Aircraft employees, faced with large-scale layoffs due to completion of Argosy AW-660 production for the British Royal Air Force, last week asked the Ministry of Aviation for stop-gap contracts to keep the work force together pending future aircraft orders.

Dr. Harry Wexler, 51, chief of Weather Bureau research, died Aug. 11 at Woods Hole, Mass. He directed the bureau's satellite and rocket programs.

Airlines Fail to Absorb Eastern Traffic

July figures indicate other trunklines did not handle bulk of business diverted from strike-bound carrier.

By L. L. Doty

Washington—U. S. domestic trunkline passenger traffic figures for July indicate that the airline industry has been able to absorb only a portion of the passenger business diverted from Eastern Air Lines which, with the exception of a few token flights, had been grounded that month by a flight engineers' strike (see p. 40).

Trunkline revenue passenger miles in July dropped 0.7% from the July, 1961 total, but this is not a realistic statistic, as Eastern filed no figures for July. Thus, the poor showing of the industry as a whole in July can be attributed to lack of participation by Eastern in the airline market.

Had Eastern accumulated the same volume of revenue passenger miles this July that it did in the same month last year, the industry would have shown an 11% gain in business, an increase on a par with the monthly growth pattern set last November. Excluding Eastern in both cases, the remaining trunklines showed a net increase in July of 322 million revenue passenger miles over July, 1961.

Traffic Lost

This compares with the 341 million revenue passenger miles handled by Eastern in July of last year, which, at first glance, suggests that traffic which normally would have gone to Eastern was almost fully accommodated by the operating carriers. However, assuming that the 10 trunklines experienced an 11% increase in traffic over and above the actual volume diverted from Eastern—or a gain of 265 million revenue passenger miles for the period—these carriers, then, accommodated only 57 million revenue passenger miles of the volume Eastern conservatively could have been expected to handle under standard conditions.

These figures include, of course, carriers unaffected by the Eastern strike—Western Air Lines, for example. Even Eastern's principal direct competitors—particularly Delta Air Lines, National Airlines and Northeast Airlines—which enjoyed substantial improvements in passenger business as a result of Eastern's suspension of most services, were able to show gains amounting to less than half the total generated by Eastern in July, 1961.

If these assumptions are correct, it could be implied that over-capacity and excessive competition are either short-range problems or have been overrated. It suggests that the operation of each individual carrier, within the over-all U. S. route structure, is an indispensable factor in the public interest, that mergers may not be a wholesome solution to the industry's current financial plight.

On the other hand, a strike is viewed as a temporary stoppage of service, and thus would not justify competing carriers underwriting heavy, long-range costs necessary to support a wide-spread expansion of services and schedules for what would be only a temporary operation. Undoubtedly, if operating carriers had called upon all their resources to augment regular services, all Eastern's traffic would have been absorbed easily.

Whether the industry could assimilate all Eastern's traffic during the winter months, when Eastern's business is at a peak, is conjecture. In any event, it is evident now that the airline industry lost a substantial volume of business, which was diverted by the strike to surface transportation, or was lost to all travel facilities by changes in plans.

One interesting facet is that although there were complaints over lack of space on some flights and shortage of service facilities, particularly in reservations offices, there has been no public outcry for immediate restoration of Eastern services. This suggests that the industry has held inconveniences to a minimum.

Latest traffic figures and financial statistics (AW Aug. 6, p. 41) also demonstrate that the airline industry can no longer be evaluated fairly by industry figures. Performance factors and financial results of individual carriers vary so widely that each airline must now be judged on its own merits—disassociated from the industry as a unit.

The 0.7% decline in traffic for the month of July is meaningless. It does not represent an average. It does not even furnish a clue to the progress or lack of progress of any one carrier. Yet the Air Transport Assn., acting in accordance with its member airlines, persists in portraying the industry to the public with figures that purport to be a barometer of the industry's condition.

Major Beneficiaries

Trans World Airlines, for example, which competes with Eastern on only a minority of its routes, suffered a decline in revenue passenger miles of almost 5% in July. Northwest Airlines, also largely outside Eastern's operating realm, reported one of the largest gains in revenue passenger miles for the month.

Delta and National were the major beneficiaries of the Eastern strike, each with a traffic increase of about 50% in July over the previous July. Each carrier reported gains in both first-class and coach traffic and each bolstered coach available seat miles by some 50% to reap the benefits of the strike, although first-class available seat miles were kept at an almost constant level.

Northeast was a slow starter in picking up the new traffic, primarily because it was without financial support until Hughes Tool Co. moved into the picture to provide it with badly needed resources (AW June 25, p. 40). The late start was reflected in a decline in both first-class and coach available seat miles during July.

Northeast reported a substantial improvement in first-class revenue miles for the month and about a 21% increase in all categories of traffic. Reportedly, the resumption of the Air-Shuttle flight by Eastern on the Washington-New York-Boston route (AW Aug. 13, p. 36) is already making inroads on Northeast's traffic volume. For July, Northeast will report a healthy 69% load factor.

Continental, which is non-competitive with Eastern but a staunch foe of the proposed Eastern-American merger, suffered a traffic decline in July, particularly in the first-class category which dropped almost 35% for the period compared with the same month last year.

Braniff Airways showed a 13% increase in traffic for the month while United had a 12% increase and American, 8%. Load factors for the industry remained at about the same level as in July, 1961, but, again, this does not reflect individual carrier success or failure in filling ever-increasing capacity.

Only Delta, National, Northeast and Northwest will report an increase in load factors, but these gains were sufficiently high to offset load factor declines by the remaining airlines which, in some cases, were extensive.

All carriers, excluding Eastern, reported major gains in coach traffic and, in July, coach service accounted for 68% of total revenue passenger miles, compared with 63% in July, 1961. For the first seven months coach accounted for 63.6% of the total, compared with 55.4% for the same period in 1961.

The Eastern strike will unquestionably pump new financial life into its competitors, particularly Northeast, National and Delta, which are not members of the mutual aid pact. Affect on Eastern—now in its 59th day of the strike—cannot yet be determined with any degree of accuracy.

Malcolm A. MacIntyre, Eastern president, recently estimated that the airline was losing about $250,000 per day in excess of mutual aid funds. Under supplemental provisions of the pact, which has yet to be approved by the Civil Aeronautics Board, Eastern can receive payments from other carrier members of the agreement equal to 25% of its normal operating expenses. Thus the carrier could receive as much as $10 million from its competitors.

Last week, however, the CAB Bureau of Economic Regulation opposed the 25% provision on grounds that it could "lead to conduct contrary to ... the Railway Labor Act." If the bureau's recommendations result in disapproval of the 25% factor by the Board, Eastern's losses stemming from the strike could be substantial, although it would still receive some benefits from the pact.

Last week, the trunkline industry reported a net loss of $5.4 million for the first six months of 1962, excluding Eastern's results. This compares with a net loss of $10.2 million for the same period in 1961 when Eastern's financial results were included in the tally.

On the surface, these comparative figures would suggest that the 11 trunk carriers had successfully pared last year's six-month deficit by about one-half. However, Eastern is expected to report a net loss of $3.8 million for the first six months which will hike total industry deficit for the period to $9.2 million, a very slight improvement over the 1961 first-half loss.

Furthermore, even if Eastern receives all it hopes to get through the mutual aid pact, its losses for July could jump as high as a staggering $7.5 million, which would move the industry loss for the first seven months far in excess of that experienced in the same period last year.

In 1962's first half, seven of the 10 trunklines reporting showed a profit (AW Aug. 6, p. 41). Of the remaining three carriers, United's loss was minor but deficits of TWA and Northeast were sufficiently high to offset gains of the profit-showing airlines. No carrier is earning a rate of return on investment that can be considered attractive to investors, but the majority of the trunklines are in far better fiscal shape than over-all industry figures indicate.

Local service airlines generated a 25.7% increase in revenue passenger miles during July, compared with the same period last year. With a 20% increase in available seat miles, load factor for July rose to 42.2% in contrast to last July's load factor of 40.6%.

Nine of the 13 local service carriers reported major gain in traffic during July. Increases reported by Frontier and Lake Central were slight and both North Central and West Coast ended the month with minor declines in revenue passenger miles. Pacific and Bonanza had load factors of approximately 50%, well above the industry average.

Continental Move

Continental Air Lines last week announced plans to transfer its headquarters facilities from Denver to Los Angeles where it will construct a $2 million, 100,000 sq. ft. building at the International Airport to house its management and administrative staffs.

The move will be made in July, 1963, and will involve the transfer of 335 personnel now located in Denver. The building will be adjacent to Continental's maintenance and overhaul base and operational center at the airport. City of Los Angeles has agreed to enlarge the carrier's lease to provide for rental of 35 acres of land for a period of 40 years.

Decision to make the change was based on findings of a survey conducted by McKinsey & Co., a New York consulting firm, which recommended that the airline centralize its activities at Los Angeles.

Loan Covers National DC-8 Purchases

By James R. Ashlock

New York—More flexibility in jet aircraft procurement will be provided National Airlines with the $5.1 million loaned to the carrier by seven banks.

The loan, obtained through a refinancing of National's bank and equipment purchase obligations, gives the airline full ownership of its present jet fleet, and will pay for three more DC-8s scheduled for delivery late this year.

The new DC-8s will be National's first turbofan-powered aircraft, and will bring its jet fleet total to six. National presently owns three DC-8s, but gains utilization of five by leasing a fourth and flying another between New York and Miami through an interchange with Pan American Grace Airways.

New plan covers all of National's indebtedness except the outstanding $10,288,000 issue of convertible subordinated debentures. The program also fulfills a pledge made by L. B. Maytag, National president, when he took office last April 26, that he would obtain new financing before delivery of the additional DC-8s.

National's original plan was to sell to Douglas Aircraft Co. its present three DC-8s, then lease them back and use the sale money to finance the additional three planes. With the new financing this plan no longer is necessary.

Tax Benefits

National wanted to avoid the sale-lease deal because under it, Douglas would retain the right to sell the three leased airplanes at its discretion. Also, by owning rather than leasing the planes, National receives the full tax benefit of depreciation over a 10-year period.

The loan agreement places no lien on equipment purchased through it, and the DC-8s will not be pledged to the lending syndicate. This is a major difference between the National loan and those that have been extended some other airlines in previous equipment financing whereby planes were mortgaged to the lending agencies. Lenders in National's case are confident that the carrier will generate enough cash flow to justify the financing without equipment mortgage.

Under the agreement, National may also enter into further cash equipment purchases to the extent of the amount of the loan it has paid off. If National desires to seek more financing for additional aircraft, the banks reserve the right of approval so far as their interest is concerned.

Maytag has said he wants to make National an all-jet airline as soon as possible. Interest has been expressed in medium-range equipment, particularly the BAC 111 and the Caravelle.

Irving Trust Co., which contributed $2,750,000 to the new finance program, was the organizer of the bank syndicate, making Irving Trust lead banker for the airline. Previously, First National City Bank of New York and Chemical Bank New York Trust Co. provided all of Na-

tional's bank financing. In the new program, First National and Chemical each contributed $12,750,000.

Other participants and amounts forwarded in the new program were Bank of America National Trust and Savings Assn., Los Angeles, $5,100,000; United California Bank, Los Angeles, $5,100,000; Bank of the Southwest, Houston, $1,530,000, and First National Bank of Miami, $1,020,000.

The program calls for quarterly repayments over a seven-year period at 5¼% interest, amounting to approximately $7¼ million annually.

Retired by the loan were $29.2 million remaining from a 1958 bank loan; $4.5 million of a 1960 demand loan; $4.6 million from Douglas, and the $12.7 million sale-lease arrangement originally proposed for acquisition of the three additional DC-8s.

Listing advantages of the new financing, Maytag said National is now less restricted toward payment of cash dividends. The carrier's previous financing was tied to 70% of net earnings, plus $500,000, subsequent to June 30, 1958. Its last cash dividend was 12½ cents per share paid in 1960. Stock dividends of 2% were paid in 1960 and 1961.

Dividend Plan

Because of heavy losses in 1960 and 1961, Maytag said, there remained as of June 30, 1962, $5.2 million to be accumulated from earnings before further cash dividends could be considered. Under the new loan plan, cash dividends can now be paid from 70%, plus $500,000, of net earnings after June 30, 1962.

The new program also releases 400,000 shares of Pan American World Airways stock held by National, and which has been tied up as collateral for the 1960 demand loan and contracts with Douglas.

Maytag said National may now explore ways to dispose of this stock in conformance with a Civil Aeronautics Board order.

National obtained the shares in an equal stock exchange with Pan Am in 1958. At that time, National was leasing Boeing 707 aircraft from Pan Am, using them to initiate the first jet service on the New York-Miami route.

Maytag said National's cash reserve will also be expanded through the refinancing because total interest and principal payments for the period are less than those scheduled under previous financing. He anticipates that the larger reserve will enable National to provide a general upgrading of its schedule performance and passenger service. He also views the broadening of National's financing base, with the addition of more participating banks, as assurance of funds to cover future requirements of the airline.

Eastern to Resume Jet Service Using Pilots to Replace Engineers

New York—Eastern Air Lines will resume jet service Aug. 23 to all cities served before the strike of flight engineers, using flight engineers who have returned to work and copilots trained for engineer duties.

Malcolm A. Macfntyre, Eastern president, said the airline is determined to restore full operation despite the Flight Engineers International Assn. strike that has prevailed since June 23 (AW Aug. 13, p. 36).

Approximately 2,000 of Eastern's 17,000 employes are back on the job, and the airline's Air-Shuttle service is continuing its 63 daily flights between Boston, New York and Washington. More employes will return early this week as city ticket and reservations offices are reopened in preparation for resumption of jet service.

The airline is making wide use of supervisory and foreman personnel in its reactivation drive. At La Guardia Airport, hub of the shuttle, only about six International Assn. of Machinists members have crossed the FEIA picket line.

Maintenance foremen from other points served by Eastern have been brought in to handle ground servicing of the shuttle service's 23 Constellations.

Eastern's jets serve 20 cities. When all resume service, and some Convair twin-engine service is restored at the same time, Eastern will be operating approximately 180 of its regularly scheduled 1,424 daily flights.

Airline spokesmen said a new strike threat against Eastern by the IAM will not affect resumption of jet service. Half of the carrier's 6,000 IAM employes voted in Miami Thursday to strike, protesting layoffs and alleged harassment by the airline.

Eastern denied the charges, saying it was willing to discuss IAM complaints but that the union hasn't accepted the company offer to meet. An airline spokesmen said no strike is imminent, as provisions of the Railway Labor Act could be enacted if necessary.

"IAM members have returned, in the numbers required by the company, as work has become available," a company statement read.

Eastern has also reported that it lost $3,806,000 in the first six month's operations this year, compared with $6,380,000 in the same period last year. Loss amounts to $1.18 per share of 3,234,616 shares outstanding, compared with $1.97 last year. However, the statement doesn't include the last seven days of June when the current strike was in effect.

MacIntyre has told Eastern employes and stockholders that the airline will be "reasonably well off" if the Mutual Aid Agreement, providing strike relief from other carriers, is approved by CAB.

"As a hedge against its disapproval, we filed a subsidy petition on July 9 (AW July 16, p. 38) and have also concluded not to return to service our 34 Martin 404 twin-engine aircraft which will be sold," MacIntyre said.

Eastern requested $23.5 million in its subsidy bid to CAB.

In a letter to all employes and stockholders, Macfntyre said FEIA had rejected Eastern's latest contract offer. Terms are now being offered engineers on an individual basis, he said.

Eastern said earlier that engineers returning after the July 25 deadline would, if rehired, be restricted to piston flights. A softening of this order is indicated in Macfntyre's letter. He said Eastern still offers to provide engineers with jet pilot training "so that they would be qualified [as jet pilot-engineers] if either the unions or the company, at its absolute discretion, permits."

The airline now offers engineers an immediate 10.8% pay increase, with an additional 3% in April, 1963, "or a higher adjustment if required to maintain the present relationship with pilot captains," referring to possible pay increases for Eastern pilots.

FEIA's latest effort to block Eastern's recovery is a complaint, filed in Flushing, N.Y. magistrate's court, charging Eastern with importing strikebreakers into New York.

A law, passed by New York's City Council June 26, prohibits bringing in "any person who customarily and repeatedly offers himself for employment for the duration of a strike or lockout in the place of employes involved in a strike or lockout."

However, the law also specifies that no company shall be prohibited from obtaining employes through "legitimate channels," even though there is a strike in effect.

Daniel Kornblum, FEIA attorney, argued that Sidney L. Elder, one of Eastern's flight engineer superintendents, was brought from his domicile in Washington to fly the airline's New York-Mexico City DC-8 schedule.

Burton Zorn, Eastern's attorney, rebutted that the law does not apply to persons already in the company's employ.

Merger Opposition

Washington—American Airlines last week took sharp issue with a recent Justice Department recommendation against the proposed American-Eastern merger (AW Aug. 6, p. 43) and used President Kennedy's transportation message of Apr. 5 to back its case.

In a brief filed with the Civil Aeronautics Board, American said that Justice opposition to the merger "runs in the teeth of the policy expressed in the President's message, misstates the applicable law and ignores the pertinent facts." The Justice opinion has been criticized privately even by opponents of the merger.

Eastern Air Lines took a similar approach in defending the merger plan. Last week, in a letter to Clarence D. Martin, undersecretary of commerce for transportation, Eastern said the merger proposals fit into President Kennedy's call for the achievement of "goals of economical, efficient and adequate service to the public . . . by the realization of genuine economies."

Pilot Union Opposes State Tax Measures

Washington—Air Line Pilots Assn. is calling for congressional legislation to counter moves by some states to withhold state income taxes from pilots who fly over their territories even though residence has been established in another state.

According to ALPA, a number of states have already passed legislation calling for withholding taxes from pilot incomes on the basis of miles and hours flown each month over such states. Few states have yet attempted to implement these statutes, although Alaska and New Jersey have requested airlines to comply with the tax requirement.

In seeking legislation, ALPA referred to laws which protect merchant seamen from paying state taxes other than those imposed by the state in which a seaman is domiciled. The union has proposed that the following be incorporated in the Internal Revenue code:

"No part of wages due or accruing to any airman, stewardess, purser, or other crewman on any aircraft of any U.S. air carrier engaged in foreign or interstate commerce shall be withheld pursuant to the provisions of the tax laws of any state, territory, possession or commonwealth, or a subdivision of any of them."

ALPA, in requesting the legislation, admitted that problem is critical in only "two or three" states at present, but noted that many states have enabling statutes and could feasibly act soon to enforce the withholding of taxes.

FAA Details Long-Range Plans To Improve Airspace Utilization

Washington—Detailed design plan for an improved national airspace utilization system, capable of being implemented in an evolutionary manner by 1969, is being unveiled this week by the Federal Aviation Agency.

The plan is the result of a year-long study by a team of FAA experts, headed by Albert Brown, to develop a blueprint for implementing the broad guidelines of the earlier Project Beacon study report (AW Nov. 13, 1961, p. 34). The new plan generally follows Project Beacon's guidelines, but in some instances it recommends different approaches. Some of the highlights in the 700-page report:

• **Separation of traffic control** and planning. Plan calls for enlarging sector area controlled by air traffic controllers, giving each controller as many as 15 to 20 aircraft to monitor with the aid of several assistants. However, a separate advanced planning team working on a multi-sector basis is to be provided to prevent high density peak loads on the sector controllers.

• **Barometric flight levels.** Under the proposed plan, all assigned flight altitudes would be based on a universal 29.92 altimeter setting. This would eliminate considerable voice communications traffic between pilot and controller and frequent resetting of altimeter. It will impose added workload on the traffic control center to assure that assigned flight level provides sufficient clearance above high terrain, but this can be handled by computers in the control center.

• **Data processing equipment.** The report details the use of computers to relieve controllers of routine clerical tasks, to provide rapid-access storage of flight plan data, to continuously monitor the situation and alert the controller of conflicts. The computer will also recommend solutions for conflicts, subject to choice by the controller. Acknowledging that it will take more than three years to fully develop this data processing capability, the report recommends that as functional portions are developed and tested, they be "peeled off and installed in the field."

• **Controller plan view display.** Principal display used by traffic controllers will be a large radar scope which shows the position of all aircraft in the sector, based on primary radar returns, transponder replies and/or computer-calculated position from original or updated flight plan. Identity of aircraft and its altitude will be displayed alongside in alpha-numeric characters. Tabular-type displays for advanced planning will also be provided, but these will be electronic and will not use the printed flight progress strip as in previous General Precision data processing system.

FAA soon will award contracts for an experimental prototype data processing and display system to be installed at its Atlantic City facility by January, 1964 (AW July 30, p. 30), as well as for a more limited computer capability to be installed at New York air route traffic control center being constructed on Long Island.

Here is the airspace structure the report outlined for the future:

Blanketing of the U.S. with positive control airspace above 24,000 ft., the first phase of the positive control expansion plan, will soon lead to the "cancellation" of jet advisory service above that altitude.

To ensure safe separation to high-speed, turbine-powered aircraft, a "minimum number of high activity airways" will be designated as positive control airspace. Using these, the jets will transition from terminal positive control areas to the floor of the area positive control airspace. At about 100 mi. out from a terminal, the conventional airway structure will resume.

At high density terminals, where ground-based digital computers would be installed, inbound aircraft would be routed to two or three "terminal entry points," then via VOR radials to their final approach course. VOR radials would diverge 5 to 10 deg., and thus offer the controller several alternatives to achieve spacing. Each route from the terminal entry point to the final approach course would involve at least two turns for more precise spacing.

Taking issue with the original Beacon report, the system design team discouraged VFR corridors or tunnels through terminal positive control area. Unqualified pilots using such routes might find themselves trapped by weather in a "blind canyon," it said.

Tackling the problem of weather data collection and dissemination, the report listed these eight packages of information that should be furnished civil and military pilots: basic airways observations, 1 hr., 12 hr. and 24 hr. terminal forecasts; 12 hr. and 24 hr. en route forecasts, 24 hr. upper-air forecasts and weekly outlooks. It then divided the U.S. into 150 mi. grid squares, each containing one "hub terminal" for weather purposes.

Each hub would collect data from observation sites, process, and oversee dissemination of the information to ATC system users.

SHORTLINES

▶ **Air France** last week made reservations for a Mexico City-bound passenger via Telstar, the first such use of the communications satellite. The call originated in the Air France ticket office in Paris and was relayed to the satellite from the French Pleumeur-Bodou tracking station. The signal was received at the U.S. Andover, Me. tracking station and was then sent by landline to Air France's Idlewild office.

▶ **Allegheny Airlines** filed a brief with the Civil Aeronautics Board requesting nonstop rights between New York-Boston and New York-Washington if CAB approves the American-Eastern merger. Allegheny also asked CAB for unrestricted turnaround authority between Providence-New York and Hartford-New York if the merger is approved.

▶ **Central Airlines'** July passenger boardings showed a 32.8% increase over July, 1961. July total of 28,382 passengers boarded was a record for Central.

▶ **Dr. James L. Goddard,** Federal Aviation Agency's Civil Air Surgeon, will return to the Public Health Service effective Sept. 1, as head of its Communicable Disease Center in Atlanta, Ga. Dr. Hilliard D. Estes has been named as acting Civil Air Surgeon.

▶ **Pan American World Airways** plans to airlift 3,500 refrigerator dealers to Hawaii between Sept. 11 and Sept. 27. Pan Am will use 159 passenger jetliners and originate flights from 20 mainland cities.

▶ **Sabena Airlines** last month showed a 44% increase over July, 1961, in passengers flown to Europe. The 6,237 passengers represented the highest Sabena transatlantic load since it began the service in 1947.

▶ **Southern Airways** boarded 50,350 passengers during July—a 51% increase over July, 1961. Southern also showed a 58% increase for the same period in revenue passenger miles flown.

▶ **Swissair** has changed its schedule on Tuesday and Saturday DC-8 flights from Chicago and Montreal to Zurich. Flights now depart Chicago at 4 p.m., Montreal at 7:30 p.m. and arrive Zurich at 7:30 p.m. local time. Returning aircraft depart at 8:30 a.m., arriving Montreal at 11:30 a.m. and Chicago at 1:20 p.m.

▶ **United Air Lines** told CAB it would resist North Central Airlines' attempt to replace UAL in serving Flint, Saginaw, Lansing and Muskegon, Mich.

AIRLINE OBSERVER

▶ Factional breach within Air Line Pilots Assn. could split the union if Clarence N. Sayen, former ALPA president, is retained beyond the end of this month as a full-time consultant. A number of pilots of American, Eastern and TWA, who are worried that newly elected president Charles Ruby (AW June 11, p. 42) may not be assuming ALPA leadership quickly enough, are threatening to withdraw from the union to start a new association if Sayen continues to take an active part in ALPA affairs.

▶ **British Overseas Airways Corp. last week said it was canceling its pooling arrangement with Ghana Airways on the Accra-Europe-London route after a four-year association. Reason is that Ghana Airways recently completed a similar agreement with Alitalia via Rome and accepted the Alitalia general sales agency in Ghana, a situation BOAC said was incompatible with its own agreement. In particular, BOAC said Ghana Airways, as general agent for both European carriers, would have to reveal traffic for which BOAC and Alitalia were both competing. BOAC-Ghana agreement will end Nov. 10, but the British carrier said it would, if Ghana desired, continue maintenance of the African carrier's Bristol Britannia turboprop transports for a reasonable length of time.**

▶ Trans World Airlines has received $3.1 million contract from the Ethiopian government to furnish ground equipment, overhaul tools and spare engine parts for jet operations in Ethiopia. Funds are provided under a U.S. development loan through the U.S. foreign aid program.

▶ **United Air Lines will install a hot water and glycol de-icing system in its hangar at Chicago's O'Hare International Airport. Under severe winter icing conditions, the system will handle as many as seven aircraft per hour.**

▶ Federal Aviation Agency has established an air traffic control zone around Washington's Dulles International Airport that extends 5 mi. in radius from the center of the airport. Zone includes three extensions projecting 1 to 2 mi. beyond the zone's border to cover IFR landings and takeoffs.

▶ **Czechoslovakia Airlines last month inaugurated new service between Prague and Conakry via Marseilles, Rabat and Dakar using Russian-built Il-18 turboprop transports.**

▶ Southern Air Transport, a supplemental carrier, has been authorized by the Civil Aeronautics Board to operate 20 round trip cargo flights between Miami and San Juan, Puerto Rico until Aug. 31 because of a backlog of cargo shipments created by the Eastern Air Lines strike. Commonwealth of Puerto Rico told the Board that demand for cargo space exceeds the supply and that Riddle Airlines is unable to increase its cargo capacity.

▶ **Air traffic controllers in the Boston center, angered by punitive action taken by FAA against their colleagues following recent reports of near midair collisions are protesting by joining the National Assn. of Government Employees (NAGE). Contention of most controllers is that the ATC system, rather than the individual, is the prime cause of such incidents. Organization of the Boston controllers under NAGE reflects a desire for more vigorous leadership than that offered by the Air Traffic Control Assn. However, FAA Administrator N. E. Halaby is understood to oppose even limited unionization of controllers and may seek to limit their participation in NAGE at least until Congress takes action on his bill to form a semi-independent Federal Aviation Service.**

▶ Qantas Empire Airways has withdrawn its bid for Tahiti as an intermediate stop on the South Pacific route (AW Dec. 4, p. 47) with no explanation. Although State Department once said that the Australian airline was entitled to serve Tahiti under an agreement supplementing the bilateral between U.S. and Australia, pressure against the stop by other governmental groups and U.S. carriers has been strong.

▶ **Two more contracts totaling $228,430 have been awarded by the Federal Aviation Agency under its supersonic transport research program (AW June 25, p. 36). Both were awarded to Republic Aviation Corp., one for research in hydraulic fluids and the other for research in seals for use with hydraulic fluids and sealants for engine and airframe applications.**

U.S. Urged to Avoid Capacity Restriction

(First draft of a White House study on U.S. international aviation policy is being circulated. The following comments on what this policy should contain were made for Aviation Week & Space Technology *by John W. S. Brancker, former traffic director of the International Air Transport Assn.)*

By John W. S. Brancker

Is the main objective of the U.S. in developing an international aviation policy to own and operate the most comprehensive system of air services compatible with sound economics? That would be reasonable on all counts.

Or is it to dominate world air transport? That would not.

There is no need for detailed proof to support the validity of the first objective, but two main arguments can be given. First, the U.S., as a world leader, must show its own flag and provide its own means of communication on a major scale. Second, as a manufacturer of aircraft, it must display its wares abroad in such a fashion that there is considerable inducement to buy for competitive reasons.

Objectives Met

To a very large extent these objectives have already been met, and the major cause for alarm in the international field is the fact that the percentage of traffic to and from the United States moved by foreign flag carriers has increased, with a corresponding drop in the percentage carried by the U.S. operators. Financial results also have been disappointing.

Let us, however, be clear. The traffic actually carried by the U.S. flag operators has increased; it is only the percentage of the whole which has fallen. The situation has been aggravated by a bad year on the North Atlantic in 1961, and there are no immediate signs that the prospects for 1962 are very much brighter unless fresh sources of traffic can be generated from Europe. New foreign flag carriers have moved into the picture, not only giving rise to additional competition, but in certain areas have shown an inclination to charge less than agreed International Air Transport Assn. fares. Furthermore, some countries have placed restrictions on the frequencies and capacities offered by U.S. flag carriers, which do not appear to be in keeping with the terms of the relevant bilateral agreements.

The basic questions at issue:

- **How important** is percentage of total international traffic carried by U.S. operators?
- **Will this percentage** continue to diminish unless drastic steps are taken to sustain it?
- **Will restricting the capacity** and frequency of foreign flag carriers be effective in protecting U.S. interests?
- **What policy on fares and rates** will give the U.S. operators the greatest opportunity?

Consideration of the percentage carried by U.S. operators can lead to some rather surprising conclusions. If we accept the idea of equality of opportunity as expressed in the Bermuda Agreement and the elimination of any form of capacity predetermination, we are left inevitably with the concept that the traffic, within certain limits, must be allowed to find its own level, and to move by the carrier which it prefers. Taken to an extreme, improbable, but stretching logical conclusion, this could mean that if all the traffic preferred, for some obscure reason, to use foreign operators the share of the U.S. carriers could be nil. It might work in exactly the reverse direction, with the share of the foreign flag carriers being nil. Strangely enough, it could happen in either case without there being grounds for invoking the post facto capacity clauses in the bilateral agreements.

This is an inherent condition of the concept of equality of opportunity, and any attempt to establish in advance the percentage of traffic to be carried by the airlines of either party, regardless of whether this is to be shared equally or allotted according to some other proposition, immediately involves predetermination of some kind.

Capacity Restrictions

Furthermore, predetermination of capacity, unless held down very tightly, can only influence, but not directly control, the manner in which the traffic moves. Exactly equal capacity, if set to match a 50% load factor, could not prevent 80% of the actual traffic being moved by one airline and 20% by the other—if that is the way it wanted to go.

Even if predetermination of capacity were accepted as desirable, is there a practical and acceptable way in which division could be achieved on any basis other than equality between the two parties? In practice, what cogent arguments could be used to support a capacity split of, let us say, 70/30 in favor of the U.S.? There are many theoretical possibilities, such as division according to population, division according to traffic generation, or division according to the nationality of the traffic. But are any of these really capable of calculation and, more important still, general acceptance?

It is also worth stressing that in any approach of this kind both parties are limited, even the one with the larger share, and a very inflexible pattern is produced which may well be harmful to everyone concerned.

Compression of capacity raises load factors, but it tends also to benefit the carrier with the lowest load factor. Would it be possible to stiffen the very amorphous wording of the Bermuda Agreement, relating to "capacity being based on the needs of third and fourth freedom traffic," by saying that if the actual load factor for this type of load sinks below a given figure, say 55%, the carrier concerned must reduce capacity accordingly? There are possibilities here, but a good deal more definition would be needed, and the 'hows and 'whens' would also have to be spelled out.

No Redress

We must be quite clear, too, that this is essentially a capacity clause and would do more to keep carriers in good economic trim than to redress any balance in carryings. Moreover, it would be very difficult to apply in a changing market. It would also call for some intricate and probably arguable examinations of actual carryings which may not yet be a practical proposition.

Without embarking on a full-scale policy of protection, there seems to be no way to alter percentages carried by U.S. flag carriers, and such a policy would be countered by every protective device which could be mustered on the other side. Apart from engendering considerable ill will which would manifest itself in directions quite distinct from aviation, the ultimate result would certainly be effectively to reduce the size of the present U.S. air transport effort and to stifle its growth.

Apart from politics and prestige, is it in fact imperative for 50% of all traffic to and from the U.S. to be carried by U.S. flag carriers? If it can be done without a rigorous and restrictive system of compulsion, it is patently desirable but under any form of competition, this is more a question of salesmanship than anything else. It is very improbable that the present percentages will fall farther, and it must be remembered that the unfortunate economic results on the North Atlantic in 1961 were in essence due to each carrier making a fairly savage attempt to secure a bigger share of the market, some to attain the goal of 50%, others to increase it.

From a hard commercial point of view, it is possibly preferable for the U.S. flag carriers to move a smaller proportion of the total traffic profitably, than to carry a larger share at a loss,

provided that their actual earnings increase.

Capacity in itself is not a sales attraction. Frequency is but when it has passed a certain point it also begins to lose some of its potential. The best and sharpest cure for overcapacity is money but even governments bolstered by nationalist sentiments get tired of paying the bill.

Although the effects of subsidy have been exaggerated they cannot be forgotten. Subsidy cannot easily be defined and because of its very nature, to try to deal with it internationally comes close to interfering in domestic affairs.

Any major government if its airline is given a fair break would prefer to see its carrier operating on a sound economic basis and without financial assistance. For the moment one must exclude new countries with new airlines but the impact of these is small, and the bulk of the traffic is being moved by well-established operators.

The complete rejection of subsidy on international routes cannot be written into any legal treaty but the climate is now propitious for a friendly approach by the U.S. to the major competitive nations for its elimination to the greatest degree possible, particularly on routes directly affecting U.S. territory.

Scope Needed

This may appear to be loose and wishful thinking but the facts must be faced. If the U.S. wishes to lead, it must lead and not compel.

If the U.S. carriers can hold their own as they should be able to, against legitimate foreign competitors, they need scope—not fetters. There will always be irrational countries which will impose restrictions on U.S. carriers where no restrictions can be justified. But this is no reason for the U.S. also to be irrational.

The aim should be toward the greatest degree of freedom, and the U.S. should make it quite clear that capacity and frequency restrictions will not be applied to foreign competition except where the other country concerned has applied restrictions to U.S. carriers, and then only after due deliberation and making every effort to have those restrictions removed.

There is one aspect which is worth particular attention and that is the question of fare levels. The quickest cure for most of the ills besetting the North Atlantic today would be an intelligent reduction in the fares. A straightforward commercial answer to overcapacity would be infinitely preferable to artificial restriction—particularly when restriction played back can be ultimately harmful.

The concept of completely open fares has certain attraction, but they may be elusive and can be risky. An open fare situation, if it could be brought about, would certainly lead to lower rates, but there are two questions which cannot be answered with complete assurance.

- **Can an open rate situation be established?** Even if the Civil Aeronautics Board refused to approve relevant IATA resolutions, it is quite possible that other governments would not accept the idea, and would seek to apply relevant clauses in bilateral agreements, either pushing the carriers together again to reach a new agreement, or insisting on inter-government discussions to establish appropriate levels. Failing action under these headings they might well refuse entry of other carriers unless fares according to their own particular ideas were applied.
- **Would competition pull fares down to a level beyond which even an efficient carrier could survive—assuming open rates were accepted?** The psychology of a rate war is complicated but there is such an overwhelming desire to be the cheapest that there is a danger that before settling collectively at the lowest reasonable level some carriers would pass the safety point and would consequently be followed by others. The situation would be kept in order to some extent by the general reluctance to pay subsidies, and to lose money, but there would be a period of confusion and uncertainty which would not be wholly beneficial either to the public or the airlines.

There is, in fact, no practical experience of such a situation. Where there has been an official open rate situation in the past very little has happened, partly because carriers were afraid to step into the dark, but primarily because they wanted to keep closed rates and knew that agreement would almost certainly be reached in a fairly short time. Certain governments also made it clear that they would not accept drastic changes.

John W. S. Brancker was traffic director of the International Air Transport Assn. from 1953 to 1960, when he left the organization to establish Consultair, Ltd., a firm of aviation consultants which he now heads. He began his aviation career in 1929 as the first executive trainee of Imperial Airways, predecessor of British Overseas Airways Corp. He was made manager for Imperial in Central Africa and later was made responsible for the carrier's route structure in Europe. In 1946 he was named commercial director and deputy director general of British European Airways. In 1947 he was recalled to BOAC and was named general manager international affairs.

Open Rate Benefits

Paradoxically, the benefits of an open rate situation would only be felt if it was quite clear that it would last some time and that government action would not be taken except in extreme circumstances.

Although carriers would be free to try their pet theories in the way of fares, it would be wrong to suppose that there would be a number of widely differing fares between carriers in an open rate situation. The position would be very much as it is for domestic U.S. services. Carriers would in due course reach the lowest common denominator and this could be achieved by agreement.

While more attractive fares would be beneficial, disorder would not—and if the same effects can be obtained without bewildering the agents and the public, it would be better to follow this course.

It is clear that an open rate situation cannot be achieved unilaterally. It will only work satisfactorily if there is some measure of agreement between governments to let fares find their natural level, failing a sensible agreement between carriers.

The greatest danger is that the reaction to lower fares might be for some countries to apply capacity restrictions to protect their national carriers and to hold away cheaper competition in this manner.

But this is a danger which may well be worth facing, particularly if the U.S. is ready to be liberal in its own treatment of capacity.

There is a lesser problem in the best method to deal with foreign operators flying to the U.S. with older equipment and anxious to charge lower fares. The word "lower" becomes academic in the face of an open rate situation and the recent tendency to insist on charging the IATA level is possibly unwise. If fares on modern jet aircraft are established at the optimum level, operation economically below them will become extremely difficult, except in the case of

MOHAWK CHOOSES BAC ONE-ELEVEN

Mr. Robert E. Peach,
President of Mohawk Airlines Inc, says

'Mohawk Airlines is pleased to be the first regional carrier in the United States to purchase the BAC One-Eleven. After intensive study we believe it to be ideally suited to our routes, the first pure-jet powered aircraft to be both adequate from a capacity point of view for Mohawk's heaviest segments, yet economic to operate over relatively short distances. We are proud to have shared in some of the developmental thinking of this aircraft which will provide Mohawk's customers with the finest jet equipment available.'

BAC

JET SUCCESSOR TO THE VISCOUNT WITH EVEN BETTER THAN VISCOUNT ECONOMICS

ONE-ELEVEN

TWO ROLLS-ROYCE SPEY TURBOFAN ENGINES

THE SHORT HAUL JET

BRITISH AIRCRAFT CORPORATION

ONE HUNDRED PALL MALL LONDON SW1 ENGLAND

USA BRITISH AIRCRAFT CORPORATION (USA) INC 399 JEFFERSON DAVIS HIGHWAY, ARLINGTON 2, VIRGINIA

charters. There will always be the exceptional cases, where fully depreciated equipment can be used to provide a type of service which will appeal to a certain public, but the attractions of this kind of limited operation and its practicability will tend to diminish and leniency over fare levels may be necessary to obtain liberality over traffic rights, which are much more important.

Thus it may be concluded:

- **United States must avoid** as far as possible the application of capacity restrictions, however attractive they may seem, because they will not serve the intended purpose and may well lead to a fashion in restrictions which will be ultimately harmful to U. S. flag carriers.
- **Capacity or frequency restrictions** should only be applied against national carriers whose own governments have unreasonably restricted American operations, and then only when warning has been given and every effort made to have them lifted. This certainly should not preclude discussions with other countries on capacity problems, but the basis should be the necessity for all carriers maintaining satisfactory payloads, rather than restriction for competitive purposes.
- **Working arrangements** should be reached with as many responsible governments as possible to avoid the use of subsidy as a competitive weapon.
- **Working agreements** of the same type should be reached to encourage fares to fall to the lowest economic level, but not beyond it. This need not be done by the deliberate disapproval of IATA rate agreements, but by making it quite clear that such agreements will not be acceptable unless they meet an appropriate yardstick, and that if no agreement is reached, carriers will be left for an appreciable period to work out their own salvation.

While some control is essential, we are dealing with an expanding industry, and I suspect that no degree of wisdom yet exists which could devise a system of restrictions which might not prove insufferable in a few years' time. There is no call for the U. S. to give away its birthright, but at present, a policy of freedom will be safest.

TWA 880 Promotion

New York—Upgraded meal and bar service in Convair 880 coach sections is being offered by Trans World Airlines in an effort to attract more business travelers. Convair coach seating is five abreast. Hot meals replace snacks, and cocktails are sold.

Regular coach fares prevail, but TWA says the fare is still $21.10 less on Chicago-Los Angeles round-trip than the new business coach fare proposed by Continental (AW Aug. 13, p. 37).

New Dallas Runway Threatened By FAA Administrator's Criticism

By Erwin J. Bulban

Dallas, Tex.—Dallas city government was urged last week by Chamber of Commerce aviation officials to initiate construction of an 8,000-ft. parallel runway at Love Field despite a furor raised here by Federal Aviation Agency Administrator N. E. Halaby's remarks before a Senate appropriations subcommittee that FAA would not spend "another nickel" on the airport.

Problem facing Dallas civic leaders here was the effect of Halaby's remarks upon the marketability of $8 million in airport revenue bonds the city planned to issue to defray the cost of building the new runway.

FAA Rejection

This was a responsibility the city had assumed after FAA had rejected its request for federal aid to assist in land acquisition, runway and taxiway construction and attendant lighting in 1960.

With Halaby departing from Washington for a week's vacation shortly after his testimony before the subcommittee, Dallas officials were at a loss as to whether he was referring to a surprise cancellation of FAA's planned program to install $250,000 in instrument landing and $130,000 in approach lighting systems to support the new runway at the airport.

Should this be the case, Chamber of Commerce aviation officials recommended Dallas should weigh the possibilities of obtaining the ILS and related installations with its own funds and pay the costs of FAA tests to correlate the equipment.

City council, which has signed an agreement with a San Antonio contractor to build the new runway and taxiway, has authorized expenditure of approximately $1 million initial financing to start the project, but has yet to issue a work order to the contractor to begin.

Ground-breaking ceremonies were to be held last week.

Bond Sale

The city had planned to market approximately half the $8 million in bonds at the present time, but indications are that the effect of Halaby's remarks may depress the market or possibly require that the interest rate on the bonds be raised to make them more palatable to the public.

The issue was further complicated by interpretation of Halaby's remarks that FAA would spend no further funds on Love Field so long as there was a "darn good jet airport" [Amon Carter Field] halfway between Dallas and Ft. Worth," as pressure by the administrator to force Dallas officials to sign an agreement with Ft. Worth to share facilities at Carter Field.

Carter and Love Field rivalry has been a thorny local dispute between the two cities since Carter Field has been in operation.

Fuel was heaped upon the flames when Ft. Worth officials suggested that Dallas leaders sit down with them and discuss proposals to share the airport.

Dallas aviation council members termed these proposals as "completely unrealistic and contrary to our own interests."

Ft. Worth disclosed a new plan for the airport which envisages enlarging the present size from 2,500 acres to 6,000 acres, rebuilding the present runway system into a staggered parallel system with completely new terminal facilities which will be situated on a 450-acre area located between the runways.

Basic Problem

Basic problem seen by Dallas officials is that any move from Love Field would eventually spell the doom of what they term a $42 million investment—with $25 million in obligations outstanding that are still to be paid off from airport revenues.

Although previous Ft. Worth proposals have been finally rejected, the Dallas aviation council last week stated that "we are always happy to explore areas of cooperation between Dallas and any other community provided the discussions are undertaken on a realistic mutually acceptable basis."

Civic Pride

Halaby referred to Dallas' insistence on use of its own airport as, "a pure, unadulterated case of childish civic pride."

Dallas Mayor Earle Cabell and Chamber of Commerce president Avery Mays reacted swiftly with letters to members of the subcommittee which termed Halaby's remarks as "reckless statements" which "have done injury to this community," also stating that he "has demonstrated a personal prejudice against Dallas . . . a reckless disregard for facts . . . and has further raised grave doubts as to his qualifications to administer the vast power vested in the office of administrator of the Federal Aviation Agency."

RAYTHEON SPARROW 3 firing sequence from Navy/McDonnell F4H-1 interceptor is shown in four stages, top to bottom. In top photo, Sparrow has been ejected from semi-submerged position in fuselage. Second, motor ignites as the missile drops free of the belly and accelerates. Bottom two photos show thrust build up and further motion of the Sparrow away from the Phantom 2 jet aircraft

FIXED TAIL FINS on Sparrow missile furnish stabilizing forces for the Navy weapon.

SparrowKeeps

By David A. Anderton

Bedford, Mass.—Raytheon Sparrow 3b, latest version in this long line of Navy air-to-air missiles, now is being tested and flown by company and Navy technicians and pilots.

The 3b version, officially designated AAM-N-6b, was designed to show performance improvement over the 3a missiles now on the McDonnell F4H-1 as primary armament. Development of the 3b, and of the 3a before it, is part of the continuing product-improvement that characterizes most contemporary weapons and their carrying aircraft.

Sparrow has been continually updated to keep it a contemporary weapon. Improvement areas have been increased range, operational altitude, and launch speeds.

Sparrow 3, which first went into service with the Navy as armament for the McDonnell F3H-2M, is a weapon designed for subsonic launching aircraft. Both the 3a and the 3b have the capability of supersonic launch.

Tailoring these performance improvements into the same airframe envelope and within the restrictions of a modest development budget is a challenge to the engineering teams assembled at the Raytheon plant here. The overriding consideration in any portion of this product improvement program is that new weapons must be completely compatible with the ones they replace. This means no changes in configuration that would change the aerodynamics of the carrying aircraft, no demands for just a few more black boxes aboard the carrying aircraft, no major increases in weight or length of the missile itself.

Raytheon engineers, aware that there is growth potential built into the F4H-1, believe they will be able to take advantage of it to continue improvement of the Sparrow. Some of them believe the Sparrow will continue in production through this decade, and will continue to arm the Navy's supersonic interceptors during that period.

Air Force has ordered a small batch of the missiles through Navy for use during the test program on the two McDonnell F-110s now being flown by USAF pilots (AW July 30, p. 39). Future procurement depends on the results of those tests plus other factors.

Currently, the missiles are operational on the McDonnell F3H-2M, which carries four Sparrow 3 rounds externally on pylons, and on the McDonnell F4H-1, which carries four Sparrow 3a rounds in semi-submerged installations in the fuselage belly, and can carry two more on wing pylons close inboard. The Sparrow 3 has been in the fleet since June, 1958, the Sparrow 3a since last October.

Raytheon is armament integration manager for Navy on both these aircraft, responsible for tying its missile to the Hughes radar system on the F3H and Westinghouse system on the F4H.

Sparrow 3 program is centered at Raytheon's Missile and Space Division, with program management concentrated in this plant. Initial work on the program began with a research and development contract award in June, 1951. First production contract was let January, 1958, and six months later the Navy declared the Sparrow 3 operational with aircraft of the Seventh Fleet in the Pacific. Since then, the weapon also has joined the Sixth Fleet in the Atlantic.

Sparrow speed is more than Mach 3. The Navy says that it is an all-weather, all-aspect missile, which means that it can take on targets from any bearing with respect to the target and in any kind of weather that can be mastered by the carrying aircraft.

Sparrow 3 owes its current form to a basic configuration developed by Douglas Aircraft Co. for the Sperry Sparrow 1, which dates back to 1946. Sparrow has since grown in length and strength but the basic geometry of the aerodynamic airframe remains the same.

Airframe Design

It features four cruciform wing and tail surfaces mounted on a cylindrical body tipped with an ogival nose cone. The wings span 40 in. in their present, clipped-delta form and are used to provide both lift and maneuvering forces. A hydraulically powered servo-system moves the wings in pairs to pitch or yaw the missile in flight. Fixed tail fins supply stabilizing forces.

The body has an 8-in. diameter and is 12 ft. long. The ogival radome is made of aluminum oxide, a ceramic material, to take the high temperatures of flight at supersonic speed and to provide a window for the operational X-band frequency of the Sparrow's guidance system. Remainder of the airframe is aluminum alloy.

Raytheon builds the missile section from the nose cone to the trailing edge of the wings, plus the tail fins and the tail cone. The rest—essentially only warhead, and rocket engine—is provided as government-furnished materiel and is sent directly to fleet units for on-site assembly with the Raytheon product.

Weight of the Sparrow 3, ready for firing, is about 400 lb.

The missile is divided into six major subassemblies for convenience:

- **Target seeker,** which includes the ceramic radomes, the radar receiver and antenna, and the necessary avionic and mechanical gear to read target data and translate it into language inputs for the autopilot.
- **Autopilot,** which includes electric power and the electronic circuitry necessary to translate the target data input and combine it with measured data to get an output of control signals.
- **Wing hub,** which provides both structural support and control mechanisms for the wing. This hub contains the hydraulic system, whose operating fluids are carried to the wing actuators through holes drilled into the complicated hub itself rather than carried externally in tubing.
- **Warhead,** which is conventional explosive and is detonated by a proximity fuse. For test rounds, the warhead space is occupied by extensive telemetering equipment. Live rounds carry a limited amount of telemetry.
- **Rocket motor,** which is a single Aerojet-General 1.8 KS 7800 solid propellant engine. Packaged liquid-propellant engines have been tested on the Sparrow 3 and at one point were considered as an alternate powerplant possibility. The solid unit is now standard.
- **Stabilizer assembly,** which mounts the

McDONNELL F4H-1 Navy interceptor is armed with four Sparrow 3 air-to-air missiles stowed in the belly and two Sparrow 3 rounds carried on wing pylons. Missile fire control system is tied to Westinghouse AN/AFQ-72 radar fire control system for F4H-1.

Pace with Target and Aircraft Performance

PREFLIGHT CHECK for Sparrow 3 system readiness requires only hand cart—the AN/AWA 6 flight line maintenance unit—to supply hydraulic and electric power and cooling air. Test circuits are built into airborne gear and read in cockpit

four fixed delta fins on a tail cone attached to the rocket motor's nozzle end.

Equipment installed in the carrying aircraft is basic to the system, but has some variations between the two types—one for the F3H-2M and the other for the F4H-1—because both missile and aircraft performance are different.

Basically the system uses a large radar in the aircraft nose to perform search, acquisition, tracking and illumination of the target. Fire-control computer combines the radar data with aircraft data to produce a display for the pilot which gives him range, angle closing speed and target altitude with respect to his aircraft.

Target Acquisition

The system also feeds data to the guidance section of the Sparrow 3 before launch so that it can acquire the target right after launching without prior acquisition. Ready status of the missile is also checked by signals coming from the fire-control computer.

There is a difference in the performance of Sparrow 3 and the 3a which is reflected in the fire-control system. In addition, the large performance difference between the two launching aircraft, and the fact that much larger and more complex radar is carried in the F4H-1, makes it possible to improve the missile weapon performance even more. The overall F4H-1 system shows more radar range and more data-handling capacity in the computer than the system installed in the older F3H.

The F4H-1 system is built around the Aero-1A Missile Control System using a Westinghouse AN/APQ 72 X-band radar in the nose. This system has been reported able to pick up targets at ranges of more than 50 nautical miles (AW July 30, p. 42).

Additional improvements are continually fed into the system, on both the aircraft and the missile side, through product-improvement programs.

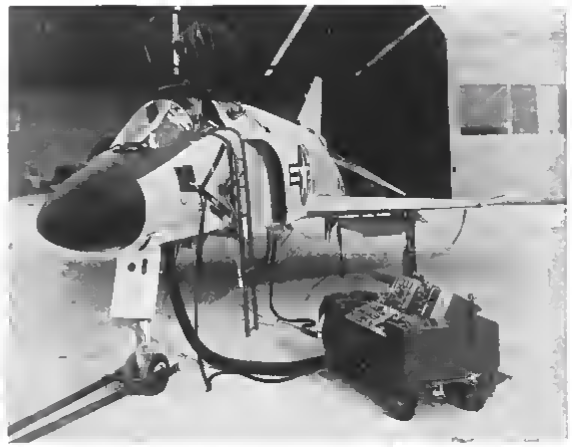
Typical of these improvements are the performance increases that characterize the Sparrow 3a version now operational with the F4H-1, and the Sparrow 3b which has been flown but is not yet operational. Another typical improvement in the system would be the ability to deal with future target aircraft of increased performance.

Time of engagement and target performance are two restrictions that force the Sparrow missile system into its present form. Contemporary fighter-bomber or fighter-fighter engagements are of such short duration that there is no time for fancy maneuvering. The weapon available to the intercepting pilot under these conditions must have speed, range, reliability and accuracy, coupled with a powerful warhead, and an instant launch capability. The pilot doesn't want to have to wait for the airborne equivalent of a countdown before the missile is under way. He wants the response from the missile that he is used to getting when he presses the trigger to fire cannon.

All-Weather Capability

He wants this capability in all-weather conditions, there's very little point in having a two-place, radar-filled airplane like the F4H-1 intercepting a target in thick cloud if the weapon available won't work in clouds, or if it's too hot, or if the sun is in the general direction of the target.

Because he may be vectored to the general area of his probable intercept, the pilot does want a missile that can fire on a collision course against a target



PERIODIC SYSTEM CHECK for fault location is accomplished on Sparrow 3 with AN/AWA-8 flight line cart which is hangar-deck equipment aboard carriers. Cart is waist high and contains automatic checkout and fault location indicators

with a heading up to 180 deg. from his own. He may not have the time or the performance for a tail chase and a rear-hemisphere attack.

Building all this capability into a missile is no mean task, and if it results in a highly effective missile, it also results in a complex and costly one. The difference between a Sparrow 3 and a Sidewinder can be measured in terms of either missile capability or missile cost. This could be one reason behind the current mix pattern being tried on the McDonnell F-110s in operational test with the USAF. These carry four Sparrows in the semi-submerged positions, and two Sidewinders on the pylons.

This gives the fighter a certain degree of flexibility and makes it possible to achieve some economy of attack. If the pilot found himself in a tail chase against a target giving him a strong infrared return, he could loose the Sidewinder and save the Sparrow for a different mission. But if he found himself on a collision course with the target flying at 90 deg. to his own heading, he would fire the Sparrow.

The intercepting pilot whose aircraft is armed with Sparrow 3s can be vectored to a prospective target or can conduct his own general search of the area. Having found and selected a target, he runs through the airborne test equipment that gives him the ready status of the missiles under his aircraft. The display in the cockpit tells him how many missiles are ready to go. He doesn't have to worry about selecting a specific missile. That is done automatically.

He monitors the radar display of the target which gives him indications of maximum and minimum range limits defining his firing point. At his option, when he crosses into the firing zone, he triggers the missile. The launch follows automatically the pilot keeps his general heading to continue target illumination.

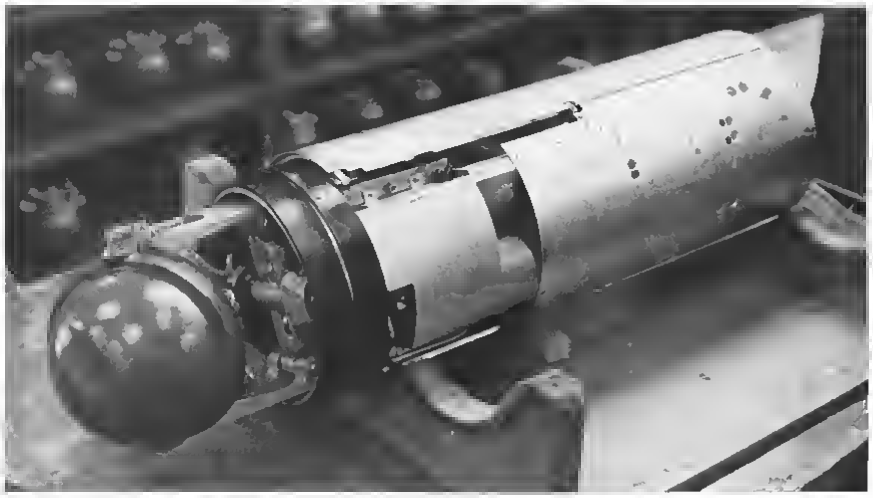
"The only thing left to do is avoid the debris," said one Navy pilot.

If subsequent engagements follow, or if one of the missiles develops a fault before firing, the system automatically selects the next missile in sequence ready for firing and tells the pilot the number of operational weapons he has left to shoot.

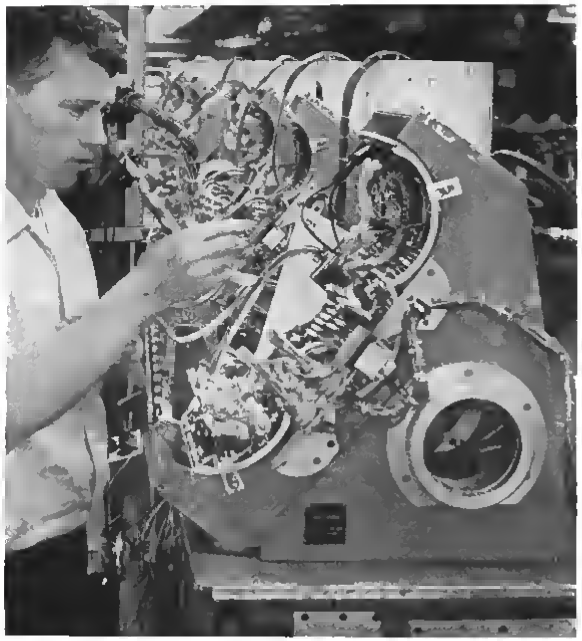
Sparrow uses a proportional navigational guidance system to fly the missile on a collision course with its target. With this system, the course of the missile is corrected continuously by moving the wings to apply a lateral acceleration to the Sparrow 3. The missile measures the rate of change of the line-of-sight angle between missile and target and the closing velocity between itself and the target, and generates signals to apply an acceleration proportional to the product of those two parameters.

The Sparrow program started at Raytheon in June, 1951, when the operating division had about 600 people in the Lab 16 building here and about 75 people on the West Coast. That contrasts with the 23,000 now in the Missile & Space Division.

Sparrow 3 was to feature a semi-active guidance system, in contrast to the two Sparrows which had been developed before it. The original was the Sperry



COMPLETE ELECTRO-MECHANICAL assembly of Sparrow 3 seeker head is ready for functional testing and inspection. Seeker dish is covered with protective metal cap painted red. Radome is attached later, with flanges shown at left end of this unit.



FUNCTIONAL CHECK of Sparrow 3 autopilot operation is mechanized for high-rate, high-quality production. Technician is shown connecting harness bundles.

Sparrow I, a beam-riding air-to-air missile that became the first such missile in the U. S. arsenal arming the Douglas F3D-2M, the McDonnell F3H-2M and the Vought F7U-3M in the mid-1950s. There was also a Sparrow 2, a short-lived version featuring active guidance. Scheduled to be built in Canada as well as in the U. S., the Sparrow 2 was dropped in favor of the Sparrow 3.

At the time that Navy chose the Sparrow 3, there was competition for the job among five different missiles. Three of them were Sparrows, with Sperry, Douglas and Raytheon as prime contractors on the 1, 2 and 3 models, and the other two were the Oriole and the Meteor.

Flight test and pilot production of the Sparrow 3 began in 1953 and was followed by a build-up in production capabilities for the missile as it began to show promising test results. Sparrow I production, then concentrated in a Navy-owned plant in Bristol, Tenn., was phased out by 1956, and the Navy turned the plant over to the Raytheon for Sparrow 3.

Current production model, the Sparrow 3a, is being built under a fixed-price incentive contract between Raytheon Co. and the Navy's Bureau of Weapons. This is the first fixed price contract in the Sparrow program, and Raytheon plans to bid for future production on the same basis. Cost of individual Sparrow missiles is not available, except in relative terms. One of these. Current rounds cost about one-half of the price of those in the first batch of production missiles built four years ago.

Total Raytheon work force on the Sparrow 3 is about 6,000, but the plant is backed up by a large network of suppliers and vendors.

Key Installations

Raytheon has three key installations for the Sparrow 3 program. These are its Bedford, Mass., plant for management, and research and development; its Lowell, Mass., factory supported by Navy-owned facility at Bristol, Tenn., for production, and an Oxnard, Calif., facility for flight-test and fleet support.

Program management is centered at Bedford, which is to become headquarters of Raytheon's Missile & Space Division in November of this year. Four technical groups at Bedford—missile, fire-control, systems engineering, and administration—manage and perform missile research, design and development. In addition a program group and a project group work at a higher level with planning problems, future applications and other technical tasks.

For production of the Sparrow 3, Lowell is considered the lead plant, with Bristol in support. From the 400,000 sq. ft. of the Lowell facility the finished "electronic rounds"—Sparrow minus warhead and rocket motor—are delivered to the Navy. Lowell is fed by a network of vendors, supplying the myriad parts that make up the Sparrow. But by far the biggest feedline to Lowell comes from Bristol, which sends all the wings, fins, airframe shells, mechanical gimbal heads for the missiles' seekers, the electronic power units and many small components.

Oxnard, which is located near the Navy Missile Center at Pt. Mugu, works closely with that center in the developmental flight testing of Sparrow 3. Raytheon maintains a supplementary telemetry station, and does much flight-test analysis on the spot with Center personnel. In effect, the Oxnard facility serves as the contractor's proving ground. But there is more than that. Oxnard also has the responsibility for design and fabrication of test equipment, and for maintenance of Sparrow test rounds. Top staff at Oxnard have been with the program about 10 years.

Quality assurance and design for reliability run through the three elements of this organization like parallel themes. Mutually dependent, they are major factors behind every line drawn on paper and every test performed on a component. Raytheon engineers say that reliability has to be designed into a part at the start. For that reason, production design starts in the research and development organization. There is no design and development of prototype units which are later completely redone to make them producible.

When Sparrow 3 was chosen by the Navy, it was a test vehicle that had to make a rapid transition to a production missile. The Lowell plant established an industrial support team, made up of engineers who are knowledgeable in such production functions as quality assurance, materials, industrial and production engineering. They were to become the nucleus of the production plant, but they set up business at Bedford to inject production engineering into the design as it developed.

Early in the design of each part this team began to establish basic production structure through bills of materials, process sheets, value analysis, and the other techniques available to the production engineer. The major mission of the team was not to design the missile, but to foresee the production pitfalls and the design detours that would avoid them.

At the same time, Bedford engineers were designing for reliability at the packaging level, checking prototype performance, learning about the modes of failure. Quality assurance people worked closely with engineers in the design stages of the Sparrow 3, determining purchase specifications, and checking and questioning potential vendors of parts.

Attention Focus

All this attention to production design and quality assurance finally came to focus on specific parts coming off production lines at Raytheon and vendor plants. In Raytheon, technicians picked off parts made at company plants and checked them for conformity to specification. Their reporting of these investigations bridged the gap between the quality assurance teams in research and development on one hand and in production on the other.

Roving inspectors, assigned exclu-

ELECTRONIC ROUND is checked (left) in final inspection stations before acceptance by Navy. Each movable wing is checked in body connection fittings. Ceramic radome (right) is ground to final contour at Raytheon's Bristol, Tenn., plant.

SPARROW 3 roars off inboard pylon of McDonnell F3H-2M Demon during Naval weapons meet. Missile has been operational since 1958.

sively to determine that parts were being made according to the process sheets, had the responsibility and authority to shut down a machine or stop an operation if there were deviations.

One out of every six employes in the Lowell production plant is an inspector of one type or another. In addition to the roving teams, there are inspectors passing on the electronic assembly work every few stations along the line. These inspectors dab each connection with red paint after they have verified that the joint has been made properly and the connections are correct.

One missile out of each month's production lot is selected for a complete checkout, after each of its components and subsystems has already been signed off as inspected and working. If a fault is found, and it is apparently a random one, the missile is repaired, but if it is a type of fault that could be a general ailment, the entire batch is checked and repaired where necessary.

Navy inspectors are on the line in final assembly, where all of the missile gets one more look before acceptance. Such final inspection is performed by the company inspectors and witnessed by the Navy inspectors, standard procedure in Navy contracting.

Finally, each lot of missiles goes through a sample test which includes a complete environmental check. Then some of the missiles are proof-fired as a further quality assurance measure.

The Lowell plant's involvement with Sparrow 3 production starts with its control over tooling for the missile. All of it is designed at Lowell, and 95% of it is made there.

Production is planned, and work centers are loaded, on the basis of units of one month's production. Raw materials are received at one end of the plant and after incoming inspection for quality are fed directly either to shears or to automatic screw machines.

Shop work centers are of two types: line production, handling large quantities of parts with a build-up to final assembly, and process production, where a number of unrelated parts receive the same kind of treatment. Example of the former is the build-up of the electronic platters that contain the seeker and autopilot, example of the latter is heat-treating.

One myth that Raytheon punctured is the old one that women can't turn out precision machine work. There are large numbers of women in the machine shop and machining process areas, working on parts whose tolerance callouts specify dimensions to within a few hundred-thousandths.

For example, the final steps in making pistons for hydraulic servo units call for grinding to close tolerances on all dimensions, near-perfect straightness of the piston, and a very fine surface finish. Raytheon tool engineers and process specialists combined the manufacture and inspection into one routine on the piston. Now women complete this operation using a fine grinder equipped with a projection-screen viewer with a dimensioned grid for guidance. The grinder head carries a probe, and is moved toward the work piece with a multiplying lever. A Precisionaire gauge gives a visual indication of the set limits for acceptable parts, and the worker can finish to an inspected dimension in one operation.

Almost all of the missile is built at Raytheon and no major subassemblies are purchased. But about 40% of the missile is bought outside in the form of raw materials, hardware, and standard components such as resistors, tubes and capacitors. Of that 40%, about two-thirds comes from small-business organizations.

Whether to make or buy a part is the subject of serious concern at Raytheon, as at other major systems contractors. The company has, and maintains, versatility in production of most of its product line, and is able to step

in and produce if a vendor or subcontractor fails to meet schedules or specifications. In the Sparrow 3, such decisions are made by committee in a procedure detailed in seven pages of instructions in the company's operations manual. Basically, these instructions say that the influencing factors are management policies, optimum plant utilization, maintenance of quality levels, minimizing schedule failures and the needs of small business and businesses in labor-surplus areas. Within this framework, the final decision is expected to be that offering equivalent material at optimum cost.

Port Construction

Most of these decisions come out to make the part. So Raytheon makes most of the missile right down to such near-standard parts as tube clips for the electronic platter assemblies, but continues to buy substantial numbers of standard parts outside.

Production at Lowell is centered on the two major avionic subassemblies of the Sparrow 3: the seeker head with its sensing and data-production system, and the computer and autopilot unit. Platters, shell framework and electronic components for these two move in steady flow through long lines of seated, soldering girls. The mechanical gimbal head for the seeker, received from Bristol, gets inspected and readied for assembly to its electronic gear.

In a separate clean area, technicians turn out hundreds of tuny gyros for the Sparrow 3 autopilot similar in design to the gyros used on the Hawk and described earlier in AVIATION WEEK (Dec. 4, 1961, p. 74).

The assembled platters, their electronics turned inside out for accessibility, then pass through separate test areas, where the seeker is checked and where the autopilot performance is measured against the simulated input of a seeker head.

Then the shells are buttoned up again, and the seeker and autopilot assemblies are joined and topped with the ceramic radome sent in from Bristol.

This essentially completes the production of the "electronic round" at Lowell. The missiles receive finishing touches in the form of decals and stenciled identifications and instructions, pass final assembly inspection, the fitting of the movable wings, and the check of igniters. The Navy accepts them, and they are trundled on their carriages into the next room for packing and shipping. There, protective covers are installed and safety-wired into place. The rounds are clamped into "coffins"—long olive-drab metal containers of about that size and shape—and loaded onto the grav freight cars waiting on the spur outside the doors.

Packed in their shipping "coffins" aboard Navy freight cars, the missiles are distributed equally to East and West Coast Naval magazines by a priority-list procedure. When a call for ship-fills is processed, the electronic rounds are sent to specific ships by routine Navy handling and there are stored in the missile magazines.

Before loading on the carrier aircraft, the Sparrow rounds are checked, two at a time, by the DSM-37 test equipment which provides a periodic status report on missile conditions. Readout of data for one round at a time comes from the DSM-37 and forms the basis for accepting or rejecting a round.

Checked rounds then are transferred to the missile ready magazine for short-term storage. From that room they are moved to the missile assembly room, which is surrounded by warhead lockers and rocket-motor lockers. Navy missilemen assemble the complete round with warhead and motor, but without fins and wings, which are installed on the hangar deck to lessen the possibility of damage during movement of the round from the assembly area to the aircraft.

The complete round then is attached to the launching pylon or installed in the semi-submerged position, depending on the type of launching aircraft, and is checked out as ready-to-go with the equipment installed as part of the airborne fire control system.

Navy conducts all the training for the Sparrow system, as it does with all of its weapons, equipment and ships, except for some highly specialized training that might be demanded by specific changes in the Sparrow. In that case, Raytheon would conduct an in-factory training program. Navy specialists in ordnance, electronics, mechanics and in the other skills of the missileman receive extra instruction in the Sparrow system in addition to the training of their specialties.

Pilot Training

Pilot training includes some basic instruction in the use of the system, cockpit checkouts and live firings conducted during squadron exercises or air weapons competitions.

Missile failures found during checkout on ship or in launching are reported back through Navy channels to the Naval Ordnance Laboratory at Corona, Calif., where the reports are recorded and correlated.

Sparrow 3 problems are relayed to Raytheon by Corona so that the company has a running check of its own quality assurance program by the performance of delivered rounds operated under service conditions. This link is the only official feedback from user to manufacturer in the Sparrow program. As al

ways there are also a number of unofficial links which also connect the Navy and Raytheon.

A realistic value for Sparrow 3 reliability could be estimated at about 95% for launched rounds, remembering that before launching, the bird has been checked three times, leaving the factors, preflight and inflight.

Sparrow 3 maintenance is based on the assumption that every missile is perfect when delivered to the Navy. But everybody accepts the reality that there will be materiel failures somewhere along the line, and that they will have to be fixed.

Maintenance Concepts

Raytheon's maintenance concepts for the Sparrow were based on the elimination of shipboard repair, and the minimizing of shipboard maintenance. Once the Sparrow 3 was delivered to the fleet, it either had to work or it was to be returned for rework. At every level of operation with the missile where checking is involved, the Navy technician gets either a go or a no go indication. He allows the "go" rounds to pass through his station, and sends the "no go" rounds back through channels.

The Sparrow 3 guidance and control section, stored as one unit aboard ship, requires periodic checking on a three-month time cycle. All system elements are checked by test equipment which simulates flight problems, monitors the missile response to the problem and then locates major components which are faulty.

Test Equipment

The aircraft portion of the weapon system is designed to be checked by test equipment which can find the fault without removing the system from the carrying aircraft. Replacement of faulty units is also planned on that basis. Test and maintenance operations for the aircraft portion of the system are done at four levels:

- **Preflight,** to determine system readiness. A small hand cart, the AN/AWA-6 flight line maintenance unit, is hauled out to the aircraft and connected to its internal systems to provide hydraulic and electrical power plus cooling air for the fire-control system. Test circuitry built into the system reads out data in the cockpit and indicates the status of the system.
- **Thirty-hour cycle,** for periodic check of the system. This test level uses a more elaborate hand cart, the AN/AWA-5 flight line cart, which supplies the required electrical and hydraulic power and cooling air, plus much automatic checking equipment and fault indicators.
- **Bench test,** to locate and correct faults. The faulty portion is removed from the aircraft, installed in a test bench system using the complete fire-control apparatus, and repaired or replaced as necessary.
- **Depot repair,** for complete overhaul. The complete fire-control system is removed from its aircraft and run through tear down, checking and rebuilding to production-line standards.

Basic Guidelines

For Sparrow 3 missiles, the same basic philosophies govern the maintenance and repair operations. If the missile doesn't perform correctly, back it comes. There is no teardown or overhaul of Sparrows aboard ship. Individual major components of the missile, such as the guidance unit or the seeker unit, may be replaced by another complete unit in the missile assembly process. But anything further is done at a depot level.

When a missile is returned because it was found inoperative, it is run through a production-line process which breaks the missile down into simple tasks and then provides a complete production-standard overhaul of the entire missile. Raytheon originally organized and operated the maintenance depots for Sparrow 3, to prove the concept. Now the depots are run by the Navy.

Shillelagh Fuse Part

Improved nose component for the warhead fuse system of Army's new Shillelagh tactical missile will be developed by Bulova Watch Co.'s Research and Development Laboratories in Woodside, N.Y.

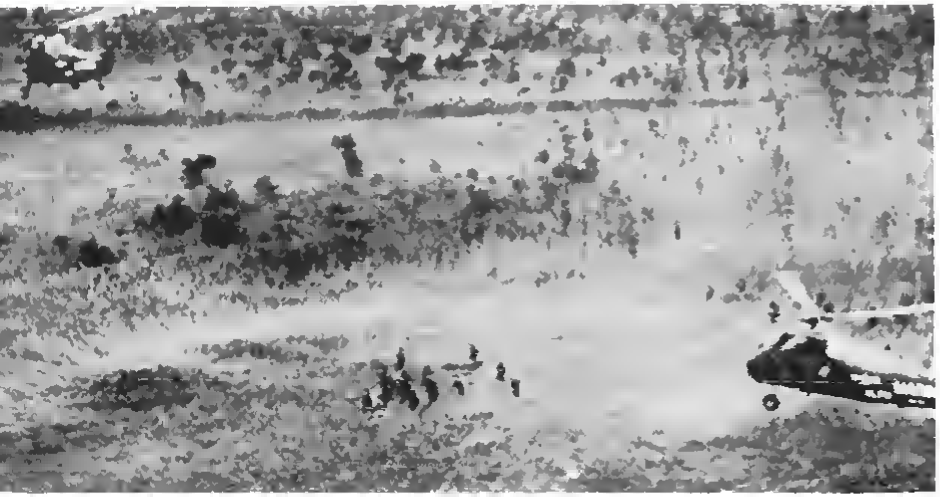
Work will be done under a supplemental $25,000 contract from the New York Ordnance District, which calls for a design of improved performance that will result in cost reductions during production.

Bulova has been a prime developer of the Shillelagh fuse system, which includes a triggering mechanism and safing-arming subsystems for the missile's warhead.

Work is directed by Army Picatinny Arsenal, Dover, N.J.

ASROC Launcher on Assembly Line

Launcher unit for Navy's ASROC anti-submarine missiles, developed and manufactured by Minneapolis-Honeywell and General Mills, is shown nearing completion on assembly line at Unidynamics, Universal Match Corp. division, of St. Louis. Launcher carries eight missiles in over-and-under position within four guides set to maintain constant 45 deg. firing angle above the horizon. Launcher can rotate 358 deg.



MARINE CORPS SIKORSKY HUS-1 helicopters of HMM 362 cover Vietnamese Rangers (above) in a raid near Xom Muong Dat. Vietnamese (below) splash through a rice paddy in the Plain of Reeds under cover of a Marine M3A1 automatic weapon in the HUS-1.

New Air Warfare Lessons Evolve From Figh

ARMY ADVISER trains Vietnamese soldiers to exit from Vertol H-21C helicopter.

DOUGLAS AD-6 pulls up after a napalm attack conducted in Vietnam terrain.

in Vietnam

Saigon—Air power in its most flexible form is giving South Vietnam civilian self defense forces, the regular Vietnamese army and the 8,000 U. S. military advisers the edge that is making the difference in the fight to block Communist expansion in Southeast Asia.

It is true that the French had unchallenged air support when they lost a war in these same jungles and mountains and had to quit the country. But that was a different sort of thing. Strategy and tactics are altered in a campaign where civic action must parallel military operations and where the U. S. is supporting a friendly local government rather than fighting the war directly.

So far, in the newest phase of a truly "protracted conflict," it has been the operations of U. S. Air Force, Army and Marine Corps aviation units, plus a steadily growing Vietnamese air arm, that have been substantially responsible for bringing the situation to a point where a top-ranking official could tell this reporter: "I can say with a cautious feeling of optimism that we are no longer losing this war."

These conclusions are obvious to the observer who has the opportunity to see this seven-year-old running battle that has belatedly caused a surge of top-echelon Washington interest in jungle fighting and guerrilla warfare.

It is safe to say that without air power,

HOW COMBAT CONDITIONS, above, differ from training conditions is shown in this photograph of Vietnamese infantry debarking from an Army H-21 in a field of tall sword grass in Central Vietnam to search for guerrillas.

NORTH AMERICAN T28s taxi out for takeoff from Soc Trang Air Base for an air strike against ground targets. Aircraft are equipped with a 50-cal. machine gun pack under each wing inboard and rockets or bombs in outboard racks.

the Vietnam war already would have been lost for the simple reason that there are no other reliable lines of communication, apart from radio, to hold the country together.

In the Vietnam fighting, the U.S. forces, Army and Marine, are writing a wholly new book on combat use of the helicopter. It would be fair to say that the whole area is being put to laboratory use for the operational testing of new machines and equipment. For example, the M-113 armored personnel carrier has seen its first service under fire, with the expected trouble reports of difficulties developing under the influence of varying terrain.

The U.S. has done much experimental work with the use of helicopters in vertical envelopment. In Vietnam, some bits and pieces of the doctrines have been used, some new ones discovered and some which sounded good in theory have been discarded. One helicopter officer said: "What we are doing in many instances could be called an adaptation of helicopter capabilities to scouting and patrolling."

There seems little doubt that the requirement for arming helicopters, for instance, has been proved but thus far there has been no sign that some of the exotic armaments tested in the U.S. have been seriously considered. There has been too much of the work-a-day demand for airlift to allow time or machines for experiments.

One young pilot, convinced he could use his helicopter as a bomber, actually made flights with rocks of varying weights, rolling them out the door, until he was convinced he could handle a 50-lb. bomb satisfactorily—if he had any 50-lb. bombs. When this reporter left the mountain base, the pilot was still seeking to convince the senior American adviser that he had something in mind other than a complicated method of committing suicide.

Legal Limit

Technically and from an international legalistic standpoint, the U.S. has exactly 585 troops in South Vietnam, including all ranks all services. That is the number allotted to the Military Advisory Group by the 1954 Geneva convention, which divided Vietnam after the French defeat and withdrawal. The U.S. did not sign the convention, neither did South Vietnam, but the Americans have gone through the motions of observing bits and pieces of the protocol.

Actually there are more than 8,000 U.S. military men here, 2,000 of them Air Force personnel. Periodically, the U.S. reports to the International Control Commission that it has 585 troops in the MAG, and simply doesn't mention that there may be others.

The active but limited participation of U.S. troops plus a domestic control problem in which President Ngo Dinh Diem interlaces his political functions with military command, create unusual and sometimes almost comic problems in protocol and operations in the midst of a deadly conflict that will greatly affect the future of the Far East.

The U.S. organization has been somewhat peculiar and is only beginning to emerge from its shakedown phase. There is unification of the sort that always works in the field but is calculated to give a visiting inspector general ulcers. The complications come from creation of a military Assistance Command for operations superimposed on an existing established MAG, which was formed originally to provide training equipment and advice. The important point is that it is working.

The Air Force operates through the 2d Advance Squadron (ADVON) sent from the 13th Air Force at Clark Field in the Philippines and commanded by Brig. Gen. Rollen Anthis, who in turn is adviser to Col. Nguyen Hinan Vinh, chief of staff of the Vietnamese Air Force. In theory, the ADVON handles all training activities for the Vietnamese Air Force. But in fact, the dividing line between training and operations is invisible.

Apart from Vietnam's own pilot and crew training, which is American advised, all military air operations are coordinated through a Joint Operations Center. This command post, set up near the headquarters of the 2d ADVON at Tan Son Nhut airport on the outskirts of Saigon, is shared across the strip from the civilian terminal and administration building. It is a good airport with concrete runways that have been handling transcontinental commercial jet flights for a long while. A new 10,000-ft. concrete runway, built on a crash basis with a strange combination of Vietnamese hand labor and the most modern heavy machinery was opened late last month. Despite its proximity to downtown Saigon, the airport is heavily guarded with machine gun strongpoints, barbed wire and minefields.

This article on air operations in South Vietnam was written for Aviation Week by Jerry Greene, military editor of the New York Daily News, who has just returned from a seven week trip through the Far East. His trip included two and a half weeks of observation of the Vietnamese air war from headquarters of U.S. and Viet forces at Saigon to remote jungle outposts.

Advisory Capacity

All military air operations throughout the country are coordinated and controlled at the JOC with Gen. Anthis working as a co-partner with Col. Vinh. A Joint Airlift Allocations Board fixes priorities for all cargo shipments and for the shuffling of transports between cargo runs and combat assault missions. Helicopter lifts, fighter-bomber strikes and close support missions are all planned and directed through the JOC. Here the Americans never command; they advise and suggest. They are ever mindful that the Vietnamese run the show.

There are only four operational U.S. air units identifiable as such in Vietnam—the Army's 5th, 57th and 93d Transportation companies (light helicopter), flying the Vertol H-21 Shawnee, and the

MAP SHOWS operational areas of South Vietnamese air war visited by the author, including joint operational headquarters at Tan Son Nhut airport near Saigon, the main training area at Nha Trang, site of the first all Viet 50-plane strike in the north and Ca Na airfield. Arrows indicate where Vietcong troops filter in from Laos. Corps headquarters location.

T-28 IS REFUELED by Marine ground crews at Soc Trang, where the Marine helicopter squadron also is based.

15,000 for 1

One man in orbit, one vehicle in space, commands the attention of millions of people. More than 15,000 persons, manning the critical ground complex, are directly responsible for success of the mission. The ground complex—involving integrated real time systems—reaches from launch sites to the remotest parts of the globe. It is in this area that many of Sperry's engineering and systems management responsibilities lie.

Sperry Microwave Command Guidance systems offer the most sophisticated techniques of drone control, and of recovery such as envisioned for boost-glide spacecraft. Sperry Loran C systems will be able to provide the most accurate range timing and ship positioning ever achieved. The Company's work in control and command computers is outstanding in the field. Phased and electronically scanned arrays using these computer technologies have been developed to an advanced degree by Sperry.

Sperry's contract with the Air Force for MARS (Mobile Atlantic Range Station) ships will see floating Stations—able to go anywhere on thousands of miles of ocean—capable of the most exacting tracking and measurement duties, and incorporating the newest radar techniques.

Whatever the requirement—control, communications or command, or the integration of the three into a system of the highest performance and reliability—Sperry has a demonstrated capability. That capability will continue to be enhanced and extended. General offices: Great Neck, N. Y.

SPERRY

DIVISIONS OF SPERRY RAND CORPORATION

Marines HMM-362 Squadron, equipped with the Sikorsky HUS-1. The companies and the squadron normally have a complement of 20 aircraft each.

Perhaps the backbone of the war, certainly from the logistics viewpoint, is "Operation Mule train." This is a combined supply-troop carrier service using about the equivalent of two squadrons of USAF Fairchild C-123 aircraft and a large number of Douglas C-47s, most of which are Vietnamese.

Mule train is something like the famed SCAT (South Pacific Combat Air Transport) and CENCATS (Central Pacific Combat Air Transport) of World War 2, but considerably more. In addition to the regular and irregular supply runs, carrying the usual stock of everything from old movie films and beer to replacement engines, the Mule train aircraft are on constant call for combat troops operations carrying both paratroops and regular infantry.

Poor Communications

Communications of all types are poor at best. Mule train aircraft are diverted quickly and sometimes without notice to half a dozen points. But they also have a schedule to maintain, and they meet the requirements. Wide use of liaison aircraft enables U.S. advisers and the Vietnam commanders to retain control and keep the operations under pressure. In addition to the faithful DC-3 under its various service and national designations, the Army's Cessna L-19, Piper L-20 and Beech L-23 aircraft are in heavy demand. Army Gen. Paul D. Harkins, head of the U.S. Military Assistance Command, uses these aircraft frequently to visit outlying posts and provinces.

Mule train itself is fed by an unending stream of heavy transports of all varieties from the Philippines and Okinawa.

Except in the C-123 aircraft, Mule train operates almost entirely with mixed crews. Americans generally ride as copilots in the Viet C-47s, still checking out the younger Viets. On several flights which this writer made the U.S. pilots seemed to be meeting their responsibilities with dignity, patience and excellent results.

The Vietnam Air Force is just emerging from the cocoon. The size in numbers of aircraft and personnel, is classified. But Gen. Anthis said: "We have almost trebled the Viet fighter capabilities since Jan. 1. There have been additions to the airlift, and considerable augmentation of their helicopters."

The first "all Viet" air strike of 50 planes was made in early June when the proud Vietnamese, flying an assortment of Douglas B-26s, Douglas AD-6s and armed North American T-28s—the hot fighter plane of the Vietnamese Air Force—hit a hidden command post and supply dump in the northern jungle area (see map). Half a dozen buildings were destroyed and at least two large fires were left burning. U.S. observers labeled the strike a success. There was no estimate of enemy casualties and no damage to any of the Viet aircraft.

Then on July 18, 11 Vietnamese helicopters joined a score of U.S. Army and Marine helicopters for the first time in a combat assault troop lift.

These helicopters, furnished through the U.S. military assistance program are Sikorsky H-19s for rescue and Sikorsky H-34s for general purpose use. U.S. Army pilots are in charge of helicopter crew training.

The Viets are only now coming out of the training phase and it will be several months before either the helicopter or fixed-wing pilots are ready to take over a big share of the combat duty.

Many of the Vietnamese pilots and crewmen have received primary training in the U.S. Some are here now, others are being trained in the Philippines, but all totals are classified. The main Viet air training base is located at Nha Trang, northeast of Saigon on the seacoast, where a substantial number of U.S. instructors are engaged in on-the-job combat teaching.

Combat Aircraft

The backbone of the Viet Air Force for combat purposes consists of the T-28, the AD-6 and the B-26, and most of the pilot instruction is transitional from primary into these types. The T-28, armed with two .50 caliber machineguns in pods under the wings, is widely used for strafing missions.

Training includes tactics and techniques, ground control, coordination with ground forces, close support, gunnery, navigation, night operations, communications, rocketry—the entire spectrum down to and including escape and evasion. Napalm has proved a most useful tool, and there is ample bombing practice.

"We fly along with them in teaching the use of the aircraft," U.S. pilots said, explaining that there is no use in wasting rockets, bombs and ammunition on practice targets when, from time to time, there are live targets available.

As one instructor put it: "This is the only war I've ever seen (he had seen two others) where you have to fight for your own training ground."

The propeller aircraft have been adequate so far in the Viet war and there have been no indications that the Viet Air Force would be given any jets. But some U.S. advisers speak wistfully of jet capabilities. They feel jets could provide a much faster response to support calls from a much more stable gun platform.

In this war, whatever else may come of it, U.S. forces are getting priceless hours of experience in the use of helicopters for battle purposes—but not without cost. Until now, the fighting has followed a simple if frustrating pattern. The Vietcong forces, in units up to battalion strength, have struck almost daily somewhere across the land at both defended and undefended villages, then vanished into the countryside. They have ambushed convoys, unarmed and armored, with deadly effect.

When the slowly improving intelligence network of the government has succeeded in locating a Vietcong concentration, using whatever secrecy it could, the government force has planned a strike or quickly set a trap. Too often, few if any of the enemy can be found but sometimes the hunting has been good.

When U.S. helicopters arrived last spring, they gave a new dimension to the government strikes, airlifting at dawn as many as 1,500 troops to the battle scene in minutes. The helicop-

VIETNAMESE PARATROOPERS board Air Force Fairchild C-123s at Tan Son Nhut air field near Saigon for a training drop at an area 14 mi. south of the field.

ters, Army and Marine alike, flew only a few feet off the ground in the flat delta country of the south. They would unload quickly and depart, sometimes returning late in the day to pick up the hunters. For a short time the Vietcong appeared to be terrorized by the appearance of the craft. Then they began shooting, and eventually picked up the knack of hitting frequently.

The ground fire is from small arms and automatic weapons. Hits on the assault helicopters have been frequent but to date rarely fatal. There have been, as officials put it, "many combat injuries for which a Purple Heart has been awarded which have not even been reported to the Department of the Army."

A notable exception was the ground fire that knocked down a helicopter last July 15, killing four Americans including Lt. Col. Tony Teneza (USAF has had 10 men killed in three crashes, one a C-123 and two C-47s.)

Many of the American helicopters have been armed with a .30-caliber machine gun, jury-rigged on a mount.

As the Vietnam Air Force began to increase its pilot capability, as communications improved, the close support operations began to expand. But for a long while, this, too, was of dubious value. The local airmen had a tendency to exaggerate.

But the Viets were eager to prove themselves; there have been instances where infantry attacks have been made purely to seize an area that had been bombed and strafed in order to pick up enemy casualties before the Cong could remove them, as they always do.

Gen. Anthis describes the VAF as "very competent, well led" and coming along about as well as elements of the USAF would be under similar circumstances. An instructor said the Viets are gaining confidence with their experience, they are getting around to coming down to reasonable altitudes for rocket firing before pressing the button.

Low-level helicopter flying has been a problem for the VAF and U.S. pilots have indeed been setting some hairy examples. In the hill country of which there is much, it is axiomatic that U.S. helicopters fly with only the rotors showing above the tree tops.

The helicopters have been virtually the sole link between some of the dozens of outpost pockets of government troops—with U.S. advisers—scattered through the mountain country. They have in many instances been the only link other than radio. Mule-train, fixed-wing planes parachute supplies and sometimes men, but nothing beats the helicopters. In this supply and evacuation work, the Viets have long been doing their share.

The supply helicopters normally fly in pairs. One will land to unload in a jungle clearing while the other hovers just above, providing cover. Then the two craft will exchange positions and the whole job is done in a matter of minutes.

All eyes now are on the Laotian border, which has been as open as a sieve for infiltration and supply by the Communist North Vietnamese, working from a big supply base in Vinh. The intermediate base for operations against South Vietnam is at nearby Tchepone, packed with supply dumps and warehouses and guarded by a full North Vietnamese battalion with six large antiaircraft positions.

Tchepone is the end of the direct Russian airlift route, and during the nine months ending last June, from 14 to 36 Russian Dakota-type aircraft landed there monthly.

During all of the fighting, airlift and troop supply, the "commercial" Air Vietnam line, using DC-3s, has been going about its business with aircraft loaded to capacity, doing a good job of meeting schedules and linking Saigon with every major community in the country. Vietnam has many airfields in varying degrees of improvement, the Americans find, and they are providing this new nation its only safe and dependable transportation.

PRODUCTION BRIEFING

Electro-Optical Systems, Inc., Pasadena, Calif., has received an $81,670 Air Force Systems Command contract to design, build and test an advanced air-jet propulsion engine which will be cooled partially by radiation regenerative methods and partially by liquid metal.

Martin Co.'s Denver Division will develop an experimental algae-filled Plexiglass case designed to produce oxygen for astronauts on prolonged space flights. Work is being done under an Air Force Systems Command contract calling for delivery of a complete solar-illuminated photosynthetic oxygenator for evaluation by the end of the year.

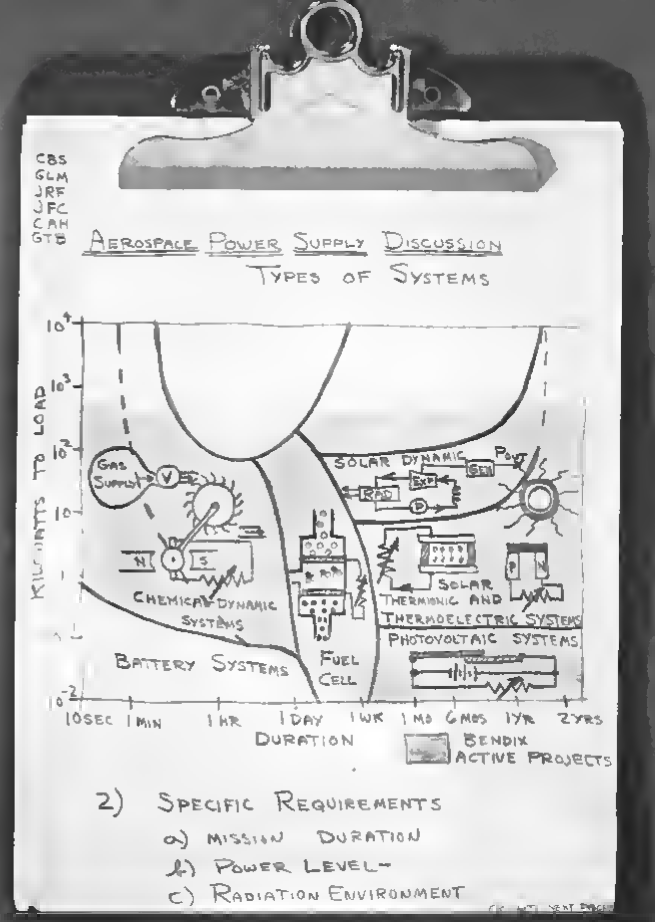
Goodyear Aircraft Corp.'s Arizona Division has received a $4-million Army contract to develop high resolution airborne surveillance radar equipment which will provide field commanders with reconnaissance information day or night and under all weather conditions.

General Electric Co. will design and manufacture equipment to adjust the directional heading of Minuteman ICBMs in their underground silos, under a Boeing Co. contract valued at more than $375,000.

Westinghouse Corp. has been awarded an Air Force contract to modify a company developed solid-electrolyte fuel cell to determine its possible future use as an electric power source in space.

General Motors Defense Research Laboratories, Santa Barbara, Calif., will conduct a laboratory study of the optical and radar characteristics of simulated missiles re-entering the earth's atmosphere under a $480,964 contract from Army's Ordnance Missile Command. Study is part of the re-entry physics research program of the Department of Defense Advanced Research Projects Agency.

Automatic ground-based target recovery system developed by Textron's Bell Aerosystems Co. has proved successful in landing the F-6K pilotless jet aircraft used as missile evaluation and training targets by the Naval Missile Center at Pt. Mugu, Calif. During recent tests, two of the drones were recovered twice by the system, which earlier had landed more than 70 aircraft in test recoveries made with safety pilots in the target planes to monitor equipment.



WHAT KIND OF NON-PRDPULSIVE POWER SYSTEM CAN BENDIX DELIVER?

The Bendix Aerospace Power Program is a centrally managed and directed corporate program which concentrates the skills of Bendix divisions experienced in non-propulsive power. The various divisions of The Bendix Corporation—participating in this program—offer a wide range of technical capabilities and experience in both basic methods of generating non-propulsive power, static and dynamic. The six divisions in this program are Bendix Products Aerospace, Pacific, Red Bank, Research Laboratories, Systems and Utica. With the Research Laboratories furnishing program management and technical direction, this corporation wide group is in a unique position to make objective trade-offs, design, and deliver the non propulsive power system that provides optimum integration of power, vehicle and mission requirements.

Bendix is—and has been—conducting Research and Development in these non propulsive power generation projects: solar cell battery systems, thermionic and thermo electric converters; fuel cells; magnetohydrodynamic generators, cryogenic and chemical dynamic systems, closed cycle heat engines.

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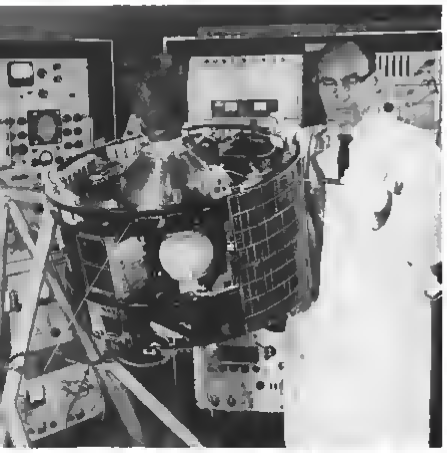
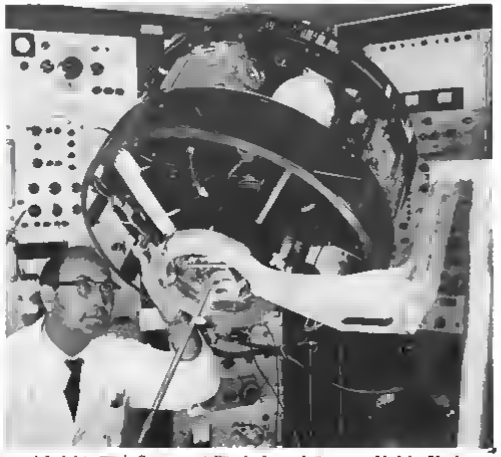




OPERATING PROTOTYPE of the National Aeronautics and Space Administration's Syncom satellite is shown being assembled by Hughes Aircraft Co. engineers. The lightweight satellite will be launched early next year.

First Syncom to Test Synchronous Orbit

By Barry Miller

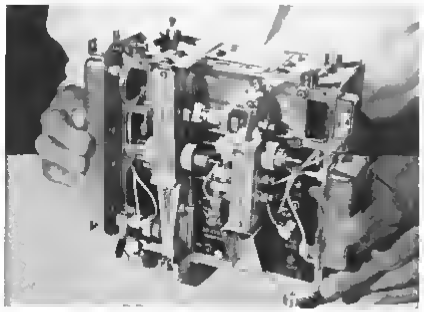
Culver City, Calif.—Initial try at placing an American satellite into a 24-hr. orbit around the earth will be made this January with the launch from Cape Canaveral of the first of three Syncom communications satellites.

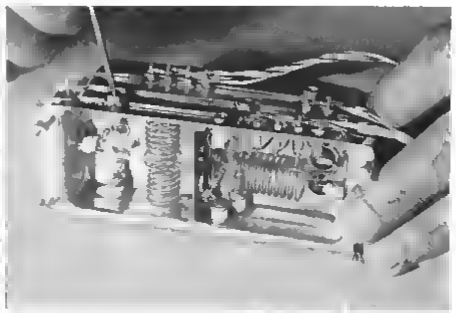
The Syncom spacecraft are entering the final stages of development and fabrication here at Hughes Aircraft Co., contractor for the satellites to National Aeronautics and Space Administration's Goddard Space Flight Center. A complete operating prototype slated for severe environment stress testing during the coming weeks was assembled at Hughes' facilities only a few days ago.

Ability of a Syncom satellite to achieve and hold the planned orbit and desired orientation, at roughly 22,300 statute miles above the earth, may have a profound bearing on the technical course of future commercial communication satellite systems.

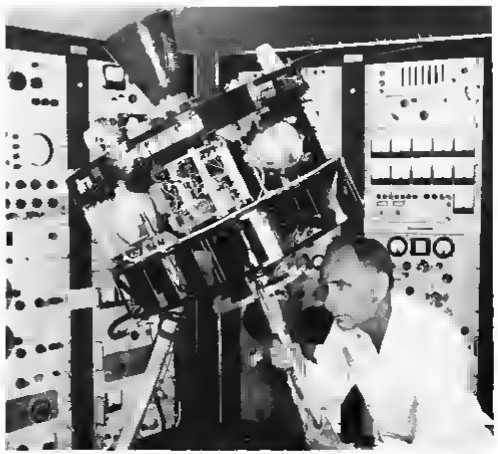
Syncom essentially will try to show that a high-altitude, or synchronous, system—with its many attractive economic and technical features, such as world-wide coverage with only a few satellites and the ability to use fixed ground antennas not only to cut complexity but to lower the costs of tying into the system—is feasible at the present stage of communications spacecraft and space booster technology.

The basic technical approach employed in Syncom is to use a spin stabilized spacecraft with orbital control exercised by two pairs of gas jets (AW Dec. 12, 1960, p. 32). This is intended to eliminate the need for three-axis attitude control which would require a much heavier spacecraft with many control jets and reaction wheels. It also would require a booster larger than the Douglas Thor-Delta scheduled for Syncom. To achieve the antenna directionality necessary to permit communications at reasonable power levels, the spin axis of the satellite must be precessed from its synchronous orbit insertion orientation so that it becomes normal to the orbital plane and its pan-





ELECTRONIC CIRCUITS of Syncom are mounted on gold-coated aluminum boards, then impregnated with polyurethane foam. Left is one of two transponders; right is seven stage varactor diode frequency multiplier which supplies reference frequencies for the transponder.



LAUNCH OF SYNCOM will be the first attempt to place a satellite in a 24-hr. orbit. Apogee rocket motor is shown in photo at extreme right. Spherical hydrogen peroxide propellant tank for jet control system also is visible at left of photo.

Feasibility

cake antenna beam covers the earth (AW June 11, p. 88).

Even in complete success, Syncom would not be the ultimate in high-altitude communication satellites. Its orbit will be inclined by 33 deg. from the earth's equator, due to Canaveral latitude and launch azimuth dictated by range safety considerations. This will prevent it from attaining a stationary orbit. And its communications gear is largely experimental and has the capacity for only a single two-way voice channel.

Hughes is working on a series of NASA contracts, however, covering long-lead time elements suitable for an Advanced Syncom satellite, intended for a stationary earth orbit, according to Gordon Murphy, manager of the Syncom project at Hughes.

The upcoming flight tests of Syncom satellites will help to evaluate:

- Performance of the spacecraft with its communication repeater system in a synchronous orbit.
- Spin stabilization and attitude orientation with gas jets.
- Time delay and echo problems caused by the finite time (nearly six-tenths of a second) required for a voice signal to travel from the user on the ground to the satellite and down to the other party and then back again.

Hence a person talking over telephone via a synchronous satellite would hear his own voice delayed in time by over ½ sec., possibly creating some confusion in normal conversations. This problem was the basis of an argument advanced by critics of the high altitude communications system against desirability of such a system (AW Feb. 6, 1961, p. 79).

But now many scientists and engineers agree that the development of new echo suppressors, such as the one demonstrated extensively by General Telephone & Electronics (AW Mar. 27, 1961, p. 33) has largely eliminated the objectionable consequences of delay.

In many respects, the Syncom satellite is similar to the lightweight communications satellite built by Hughes with its own funds almost two years ago (AW Oct. 17, 1960, p. 26; Dec. 12, 1960, p. 32). The general physical configuration of the two—cylindrical in shape or resembling a pill box—is identical. The use of spin stabilization with gas jet control, an onboard apogee rocket to provide the extra boost to place the satellite into a nominally synchronous orbit, lightweight traveling wave tubes for the communication

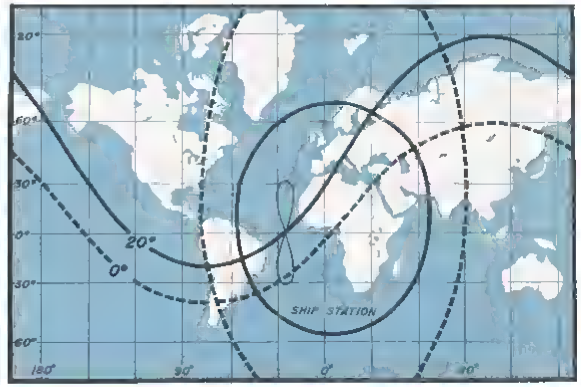


FIGURE EIGHT PATTERN shown between South America and Africa is ground projection of points over which Syncom satellite will pass in 24-hr. period, if it is placed at synchronous altitude and at 25 deg. W. longitude. Two ellipses represent loci of points at which satellite is visible from a ship station at a selected location; while parabolas indicate limits of visibility for stations at Ft. Dix and Lakehurst, N. J. Angles are elevation with respect to horizon. Lines indicate limits of vision on horizon (0 deg.), 20 deg. above horizon.

PROBLEMATICAL RECREATIONS 132

The game of reverse tic-tac-toe (known to some as toe-tac-tic) has the same rules as the standard game with one exception. The first player with three markers in a row loses. Can the player with the first move avoid being beaten? —*Contributed*

WESCON starts tomorrow! Those of our faithful readers in attendance are advised to pick up a free copy of *Problematical Recreations*, our third collection of puzzles from this series, available from Mr. Harry P. Laur who will be at the Career Center all during the show. Non-readers may also have a free booklet. Readers and non-readers alike are invited to bring a resume when calling upon Mr. Laur.

ANSWER TO LAST WEEK'S PROBLEM: Period should imagine Sigmond's tent reflected through the line of the river to the opposite side and should head directly for that point, stopping, of course, when he gets to the river. A simple indirect proof will show that this minimizes the total distance.

transmitters are all carryovers from the original concept.

Syncom is 28 in. in diameter, a dimension determined by the Delta fairing, and 15.5 in. along its cylindrical length. The entire cylindrical outer surface is covered by silicon solar cells which, with nickel cadmium batteries and necessary regulators, supply 25 w without loading the batteries when the spacecraft is unshadowed.

Total Weight

Total satellite weight is 71 lb. This includes its hydrogen peroxide and nitrogen control systems that make the velocity changes and orient the spacecraft. It also includes the solid propellant apogee rocket motor case after its fuel is exhausted. The weight after separation of the third stage of the booster will be approximately 135 lb.

The satellite itself is composed of two structures—an outer one supporting the cold gas (nitrogen) control system, solar panels and some electronics and an inner one supporting the apogee motor and remaining electronics.

Electronics carried on the spacecraft includes communications transponder, command and telemetry systems. The communications system is a redundant (dual), frequency-translation, active repeater that will receive signals at 7,361.63 mc and translate them into 1,814.16 mc for retransmission back to ground terminals. It employs dual light weight traveling wave tubes that each have two watts nominal output. Transponder receiver noise figure is 10 db, channel bandwidth ½ mc. and receiving antenna gain is 2 db, excluding losses. Total weight of the transponder is slightly more than 8 lb., and power consumption is 16.3 w.

Two Receivers

As indicated in the accompanying block diagram on p. 83, signals received by the spacecraft's slot array antenna are fed to two identical receivers, only one of which, selected by command, can operate at a time. Each receiver has its own mixer-IF amplifier and a pair of filters each followed by a limiter.

The filters have ½-mc. bandwidths and their center frequencies are separated by 1,725 mc. so that in two-way communications, signals from both transmitting stations can pass through the same receiver and be separated by the limiter-filter combinations. On emerging from the limiters, outputs are added, mixed with a reference to convert the carrier down to about 1,800 mc.

These 1,800 mc. outputs are the inputs to a single hybrid network, the outputs of which are connected to the two traveling wave tube transmitters. Either of these can be turned on by ground station command. The output then is routed to the transmitting antenna.

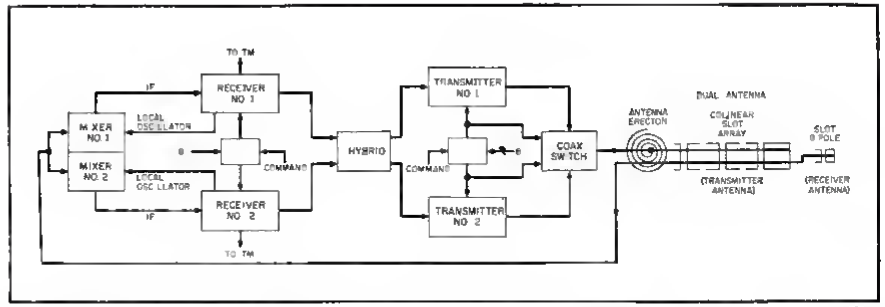
Thus the communications system has two identical receiving and frequency translating systems either of which can drive either transmitting tube to give the system parallel paths for higher reliability.

The transmitting antenna, a coaxial slot array on the spin axis, radiates a pancake-shaped beam (AW June 11, p. 88) with its plane normal to the satellite's spin axis (which in turn is perpendicular to the plane of the satellite's orbit) so that the 25-deg. antenna beam blankets the earth.

This beam produces a figure eight radiation pattern that sweeps out a saucer-shaped pattern in the axis of the orbital plane as the satellite spins. Its gain is about 6 db.

The command system is composed of a pair of dual amplitude modulated 148-mc. receivers and pulse tone operated decoders and an antenna system made up of two pairs of whips connected through balancing units to the inputs of a hybrid shared with the telemetry. The two outputs of the hybrid correspond to the two polarization modes of the whips acting as a turnstile system, Hughes engineers explain. Outputs from the hybrid are connected to two diplexers, each of which will provide 148-mc. command signals to the receivers and accept 136 mc. telemetry signals for passage to the hybrid and transmission from the satellite.

Command receivers are identical, parallel units which—after detection—supply audio tones that are applied to two redundant groups of three tone-operated channels, the company says. Power is applied continuously to one channel in each group, which turns on the other two when it gets the correct audio tone.



COMMUNICATION TRANSPONDER on Syncom has dual receivers and dual frequency translating systems, either one of which drives either traveling wave tube transmitter. Particular transmitter or receiver to be operated is selected by command.

A desired command can then be inserted by sending a predetermined number of pulses from the ground at a second audio frequency. Command will then be verified by telemetry and executed by sending a tone to the third channel.

Functions of the command system will be to turn the communication transponder, telemetry carrier and telemetry modulation on and off; select communication transmitter and receiver, telemetry transmitter and encoder and handle the control functions.

Telemetry consists of the antenna shared with the command system, a redundant pair of 2-w., 136-mc., FM modulated transmitters and two encoders. When the encoder is off, the first transmitter can function as a 126-mc. beacon for Minitrack, one of two methods to be used for tracking Syncom. Either transmitter can be turned on or off, and modulation of each can be turned on or off.

Four ground communication stations will be made available for Syncom by the Department of Defense which had planned to use Syncom in testing certain features of its now-defunct Project Advent synchronous satellite communications system. The four are the Advent stations at Ft. Dix, N. J. and at Camp Roberts, Calif. (although this station is not expected to be in line of sight of the first series of Syncom satellites), a Project Advent ship, the USS Kingsport which will be located somewhere off the west coast of Africa and a Bendix air transportable station, currently at Lakehurst NAS, N. J.

Transmitting and receiving stations

Orbit Terminology Definitions

Terms employed in describing possible communication satellite orbits include:

- **Circular Orbit**—An orbit which describes a complete constant altitude revolution around the earth.
- **Equatorial Orbit**—An orbit in the plane of the earth's equator.
- **Synchronous Orbit**—An orbit with a period of 24 sidereal hours, the same period as that of earth revolving about its axis. The term "synchronous" means that the satellite rotational speed and the earth's speed of rotation are in synchronism. There are many possible synchronous orbits but for each circular, synchronous orbit there is a uniquely defined altitude of 22,752 naut. mi. from the earth's center, or roughly 22,300 stat. mi. above the average equator altitude. If the synchronous orbit is elliptical, the semi-major axis of the ellipse will be 22,752 naut. mi.
- **Stationary Orbit**—A circular, equatorial and synchronous orbit. In a stationary orbit, the satellite appears stationary with respect to any point on the earth's surface because satellite altitude and speed with respect to earth's rotation keep it in a fixed relation to points on the earth. Thus, stationary and synchronous are not synonomous. A stationary orbit must be synchronous, though the reserve need not be true.
- **Inclined Synchronous Orbit**—Specific example of a non-equatorial, hence non-stationary, synchronous and circular orbit. Syncom will have such an orbit, inclined by 33 deg. with respect to the equator. The satellite's orbital period is 24 hr., but points on the earth have a changing relation to it.
- **Figure Eight**—This is a ground projection of points over which the non-stationary, synchronous satellite (Syncom) would appear during a 24 hr. period. The top of the elongated figure eight would be at 33 deg. north latitude, the bottom at 33 deg. south latitude, the center of the figure at the earth's equator. The satellite longitude would not change from day to day.

will use 30 ft antennas, transmitting systems will radiate 20 kw and have an RF bandwidth of 80 kc. Voice signals will be angle modulated on the RF carrier.

Hughes is responsible for telemetry receiving and command stations to be located on the USS Kingsport, at Mnutrack station near Johannesburg, South Africa, and at Lakehurst. Equipment at these sites will include ground control gear, among them a synchronous controller for spacecraft control system commands. Tracking will be handled by Mnutrack and the space craft communication ground station.

Control System

Syncom's control system, which will be a crucial element in the satellite's operation will

- **Provide a velocity increment** to bring the spacecraft to the desired longitude once it is at the synchronous altitude using the hydrogen peroxide control system.
- **Provide reaction force** with hydrogen peroxide to achieve gross synchronization when the desired longitude is reached.
- **Reorient the satellite** so its antenna beam patterns can cover the earth.
- **Achieve synchronism** with the cold gas nitrogen velocity jet system.
- **Maintain orientation** and longitude for a year.

Elements of the control system are

- **Hydrogen peroxide control** system for coarse velocity corrections.
- **Cold gas jet system** for fine velocity and orientation.
- **Four sun sensors** for spin rate and attitude determination.
- **Ground based synchronous** controllers to control pulsing of the cold gas jet system.

Final launch sequence for Syncom will depend on the final selection of a desired orbital longitude, according to Donald D. Williams, manager of the Syncom System Design Department.

Syncom will be launched from Cape Canaveral by the three-stage Douglas Thor-Delta rocket. The third stage will burn out roughly six minutes after lift off at which point the satellite will have attained a velocity of approximately 33,550 fps., and will be located at about 23 deg. north latitude and 67 deg. west longitude.

Prior to firing the third stage, the payload mounted on a spin table on the front end of the second stage is spun by small solid propellant rockets.

Third stage and payload are to be injected into a transfer ellipse, the perigee of which will be at the altitude of third stage burnout (about 150 mi.) and the apogee of which will be at the altitude of the synchronous orbit (22,300 stat mi.).

Two minutes after injection into the transfer ellipse, the satellite separates from the third Delta stage, its command antenna is erected, and the Syncom continues coasting in the transfer ellipse, maintaining the attitude imparted to it by the Delta rocket.

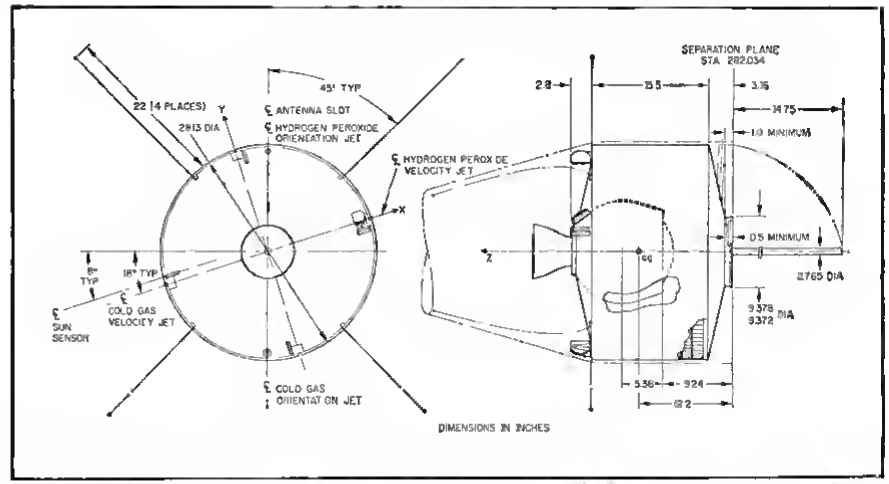
About 5¾ hr. after launch, the satellite is expected to reach the 22,752 naut. mi. altitude, equivalent to the radius of a circular, synchronous orbit. At this time a spherical solid propellant apogee rocket (probably a Thiokol TE 375 spherical solid propellant motor, or possibly a Jet Propulsion Laboratory Starfinder motor) fires by timer command and boosts the satellite from the transfer into the circular orbit. The apogee rocket effectively constitutes a fourth stage to give a velocity increment of about 4,800 fps. to bring vehicle velocity, which will have fallen to about 5,200 fps. at the end of the coasting period, to an orbital velocity of 10,000 fps.

At the apogee point, the satellite may be over the tip of Africa, at a longitude of about 22 deg. east.

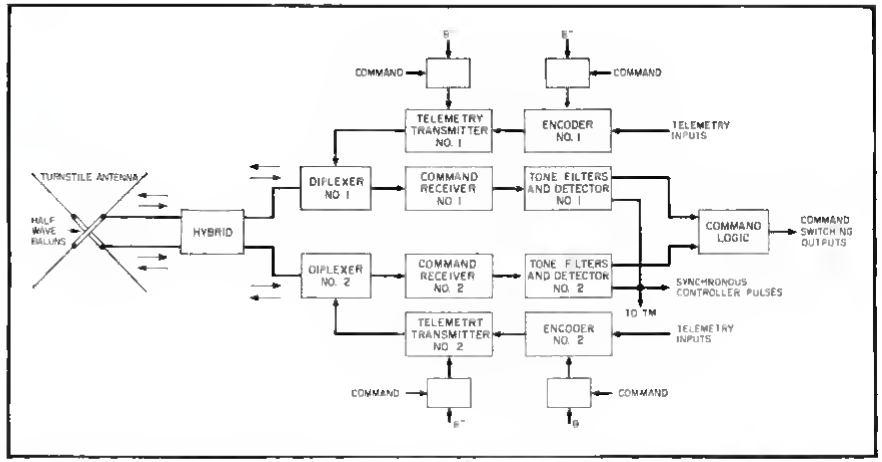
The desired longitudinal location, still to be determined, will be somewhere between South America and Africa, perhaps at 25 deg. west longitude. The satellite will be spinning about its cylindrical axis with its spin axis nearly in the orbital plane.

Satellite Tracking

After the apogee motor burns, the satellite will be tracked using the telemetry transmitter as a beacon for about an hour to determine orbital parameters, including orbital velocity. If the satellite orbit is drifting westward toward the desired longitude, at the rate of about 5 to 10 deg. per day, no velocity changes will be made. If it is drifting eastward, then velocity is applied by ground command to cause the orbit to move west. The initial correction is made with a hydrogen peroxide axial velocity jet, which supplies a continuous thrust parallel to the



RELATION OF FOUR VELOCITY and orientation jets, displaced by 90 deg. around cylindrical shaped body of Syncom satellite, are shown in dimensioned outline drawing of satellite



TELEMETRY AND COMMAND SYSTEMS of Syncom satellite share single turnstile antenna and illustrate emphasis on redundancy in electronics with parallel telemetry transmitters and encoders, command receivers and tone filter-detector networks

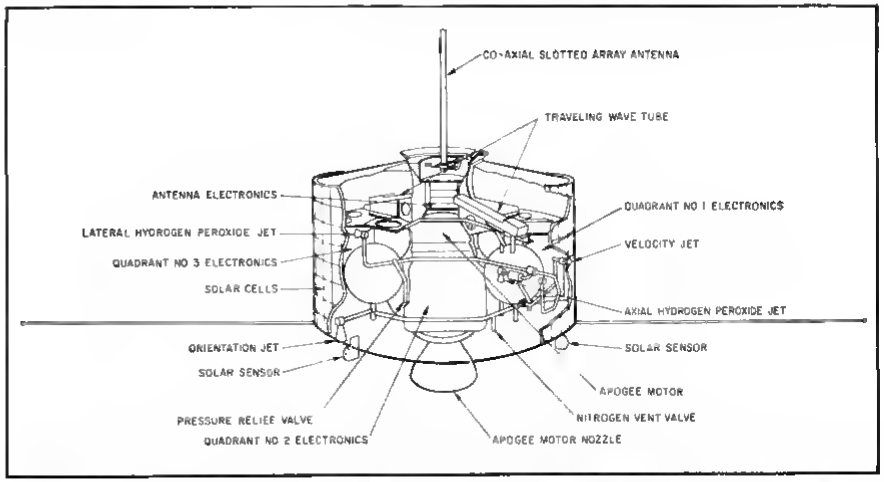
spin axis, in the same direction as apogee motor. A drift rate to the west of about 75 ft. per second will be enough to cause the satellite orbit to reach desired longitude about a week after launch.

Although the thrust of the velocity jet will not be through the satellite's center of gravity, it is continuous and since the satellite will be spinning, there will be no effective torque to bend satellite attitude.

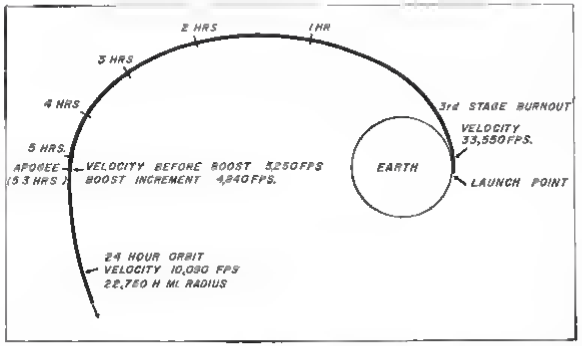
As Syncom approaches its final desired longitude the drift rate will be slowed and final corrections made on the desired longitude by the hydrogen peroxide system to achieve the synchronous rate.

Satellite spin axis then will be reoriented by a pulsed mode nitrogen reorientation jet configured like the axial hydrogen peroxide jet parallel to the spacecraft's spin axis. The pulsed nitrogen thrust will cause the satellite to precess so that its spin axis will become perpendicular to the plane of the earth's orbit. Pulsing of the cold gas system is to be controlled by a ground-based synchronous controller. A proper amount of precession may be assured by monitoring the angle between the spin axis and the sun line and the polarization of the communication antenna.

A nitrogen velocity jet provides final velocity control after reorientation and in the event it fails, a lateral hydrogen



SYNCOM ACTIVE COMMUNICATIONS SATELLITE being developed by Hughes Aircraft Co. for NASA's Goddard center has hydrogen peroxide propulsion system for coarse velocity control, pulsed nitrogen system for fine velocity control and vehicle orientation.



SKETCH OF TYPICAL SYNCOM FLIGHT path indicates that satellite will coast in transfer orbit for more than five hours after third stage burnout of the Thor-Delta boost vehicle. When vehicle reaches apogee of transfer orbit, which corresponds to the radius of a synchronous circular earth orbit, an onboard solid-propellant apogee motor fires to boost the satellite into synchronous orbit

peroxide jet can correct the anticipated 0.1 deg drift rate.

Availability of the two gas jet systems provides an additional degree of redundancy for the satellite. The hydrogen peroxide has higher specific impulse (160 sec compared with 60 sec for nitrogen) and its tankage is lighter, while nitrogen is faster acting and more accurate for pulsed operation.

Two methods of controlling the pulsed jet system further contribute to system redundancy. One of these is a ground control mode in which jets are turned on directly by command from the ground, while in the other, the spacecraft quadrant mode, the spacecraft is instructed to turn the jets on at a given time.

In the first mode, the gas jets must be synchronized with satellite spin rate, and impulses have to occur at the time the spacecraft is in the proper roll attitude so that any orientation and velocity changes are in the desired direction.

The attitude of the spacecraft, relative to the sunline, is determined in the first mode by solar sensors, and this information is telemetered to the ground where commands are generated at the proper time by a synchronous controller. This mode permits pulsing during any phase in the satellite's spin cycle.

The spacecraft quadrant mode provides a backup in the event telemetered data is not available. It employs, in addition to the sun sensor used in the ground mode, three other sensors spaced around the periphery of the satellite at 90 deg intervals.

Output beams from four sensors define quadrants of the spin angle relative to the sunline. Should the velocity or orientation jet be pulsed during one of these quadrants, the spacecraft accelerates or precesses a known amount. The jet to be fired and time of firing are selected by command from the ground.

Speed of the satellite in synchronous orbit must be about 10,087 ft per second. The one sigma error (3 probability of error) for the three-stage Delta and the spacecraft's apogee rocket after burnout is about 112 ft per second, according to Dr. Harold A. Rosen, technical director and associate Syncom project manager.

Other errors, which the control system would have to overcome include 175 ft per second per year accumulated inclination error due to lunar and solar gravity and solar pressure, 17 fps per year changes in synchronous speed along the velocity vector due to the fact that the center of the earth's mass is not at the earth's center, plus errors due to precession of spin axis due to magnetic fields.

Total Corrections

This totals over 300 fps of corrections that have to be made during a year's time—the estimated objective lifetime of Syncom. The hydrogen peroxide system will have 340 fps velocity correction capability and the nitrogen system another 65 fps. About 20 to 25 fps of this is for reorientation.

Essential difference between the Syncom and Advanced Syncom orbit is that the latter is not only synchronous and circular, but equatorial as well. This will enable an observer on the ground to view the satellite in the same position throughout the day. This characteristic considerably simplifies the type of ground transmitting and receiving antennas and supporting terminal equipment necessary to relay communications through the satellite.

Since the Advanced Syncom will use Atlas Agena B as a booster, rather than the lower-thrust Delta, it permits a sizable weight growth in the satellite, enabling it to grow to 500 lb including an apogee rocket with greater boost velocity increment than available from Syncom's apogee rocket. The ability to get into a transfer ellipse whose perigee and apogee are over the equator and the proper aiming of the satellite's apogee motor are made possible with the Agena. This will provide an efficient way of achieving the stationary orbit.

Contract Items

NASA contracts cover following advanced Syncom items:

- **Phased array antenna**, a 16-element array in which the phase of each element is controlled to produce a pencil beam pointed at the earth with its phase varying with the satellite spin rate to keep it so oriented. This will give a gain of 18 db, comparable to that of a pencil antenna on a more complicated attitude-controlled synchronous satellite (AW June 11, p. 88). The pancake-shaped antenna pattern of Syncom provides 6 db gain.
- **Dual mode communication** transponder. This will necessitate redesign of traveling wave tube to permit communications on new frequencies specified by NASA (4 kmc for transmitting, 6 kmc for receiving). Transponder will have multiple access capability, that is, it will be able to receive and send many voice messages at single time without requiring complicated multiplexing on the satellite end. This was made possible by device developed by Tom Hudspeth of Hughes which permits single side band transmission to the satellite to be converted to phase modulation.
- **Hot gas jet system**. This will be a dual high-performance, bi-propellant (nitrogen tetroxide and hydrazine) system for making velocity orientation corrections. It will have a faster response time than the hydrogen peroxide system.
- **Building of an engineering structural model**.

Advanced Syncom

Advanced Syncom, as proposed by Hughes will be a larger, more sophisticated version of Syncom. It is intended to carry four transponders, operating on different frequencies each handling 600 two-way voice channels when used with 85-ft. dishes on the ground. It could handle 300 two way voice messages with 60 ft. dishes. A number of teletype messages could be multiplexed on each voice channel. Each transponder will have the same dual transmitter and receiver features as the Syncom transponder.

The satellite will be spin-stabilized and employ the jet orientation and velocity control scheme characteristic of Syncom.

Its linear dimensions will be roughly double those of Syncom, making its diameter about 57 in. and its cylindrical length about 30 in. Like Syncom, it will have four whip antennas for telemetry and command. It is proposed that three Advanced Syncoms be built, just as three Syncoms are under construction.

Advanced Syncom will carry sufficient fuel to correct initial errors and hold against perturbations for five years.

Hughes Project Syncom people attribute a number of the satellite's features and design details to suggestions made by the Goddard project engineers. Alton Jones and Robert Darcey, who manage the project for NASA, directly contributed to design of the telemetry and command system and suggested the self-contained mode of control, according to Rosen. Jack Evans of Goddard made significant contributions to working out the satellite structures.

FILTER CENTER

▶**RADC Begins Advanced Radar Project**—Rome Air Development Center soon will award contracts for elements of an experimental Active Swept Frequency Interferometer Radar (ASFIR), which theory indicates will provide a 100-1 improvement over available radars in its ability to measure angular position, range and velocity of targets in deep space. The new radar will combine pulse-compression techniques with those of interferometry (AW Sept. 25, 1961, p. 299).

▶**Super-Speed Printer**—Printer capable of operating at speeds of 10,000 words per second, or 60,000 alpha numeric characters per second, will be built by Radiation-Orlando for Lawrence Radiation Laboratory, University of California. The printer will use a dry, electrosensitive paper in which characters are formed by electro-chemical reaction.

▶**Noise Measurements for Resistors**—The theory that potentially unreliable metal oxide film resistors can be sorted out by means of current noise measurements has been confirmed by extensive reliability tests conducted by Corning Electronic Components Division of Corning Class. The company reports that more than 23 million component hours of life tests at 250% rated power at 25C temperature on resistors screened by the current noise process have not produced a single failure (AW Jan. 15, p. 105). A brochure which describes the noise screening procedure and test results, entitled "Current Noise Level New Reliability Screening Technique," is available from Corning, Raleigh, N.C.

▶**Giant Radar Progressing**—The 1,000-ft. radar, being constructed in a natural mountainous bowl in Arecibo, Puerto Rico, is expected to be ready for operation early next year. The horizontal bowl currently is being lined with approximately 18 acres of reflecting plates, each about 20 ft. square. When completed, the radar is expected to have a beam width of about ⅛ deg. The project is sponsored by Defense Department's Advanced Research Projects Agency.

▶**Spacecraft Heat Transfer Programed**—Computer program which can be used to calculate space vehicle shell temperatures and the radiant energy impinging on the vehicle is described in a research report entitled "Radiation Heat Transfer Analysis for Space Vehicles," available for $6 from Office of Technical Services, Commerce Dept., Washington 25, D.C. The 423 page report identified AD-271917, was prepared by North American Aviation under Air Force contract.

▶**Vapor Cooling at Zero-Gravity**—"Engineering Study of Vapor Cycle Cooling Equipment for Zero-Gravity Environment," a research report now available, describes a vortex evaporator which can be used under zero gravity conditions to provide vapor cooling of avionic equipment in spacecraft. The 260-page report, identified AD 267520, is available for $4 from Office of Technical Services, Commerce Dept., Washington 25, D.C. Original investigation was carried out by Northern Research and Engineering Corp. under Air Force sponsorship.

▶**New Thin-film Component Developed**—A thin-film resistor whose resistance changes linearly with the applied magnetic field, and which has a frequency response to more than 20,000 cps., has been announced by American Aerospace Controls, Inc. The new magneto-resistive device, called "MistoR," can be applied in a variety of circuit functions, including transducers, contactless potentiometers, solid-state a-c to-d-c converters, flip flops, and computer elements. The device is available with zero-magnetic-field resistance of 100 to 10,000 ohms. Magnetic flux sensitivity is 4% per 1,000 gauss. Operating temperature range is −54C to 100C, and the temperature effect is quoted at 0.4% per degree centigrade. Company's address: 123 Milbar Blvd., Farmingdale, N.Y.

▶**Microminiature Autopilot Flown**—North American's Autonetics Division reports that it has successfully flown a Convair 240 using a microminiature automatic pilot amplifier which is only 1/20 the size of the smallest equipment currently in use. The compact autopilot uses ceramic substrate wafers with discrete semiconductor elements (AW May 14, p. 95).

▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

- **Melpar**, Falls Church, Va., will develop techniques for joining microtransistors and other discrete components to thin film and semiconductor microcircuits under a $68,500 contract awarded by Army Signal Corps.
- **Kaman Aircraft Corp.**, Bloomfield, Conn., will study use of "fly by wire" flight controls for helicopters and modification of existing autopilots for use in V/STOL aircraft and compound helicopters, under two contracts awarded by Army.

Interest Growing in Phased-Array Radar

By Philip J. Klass

Washington—Vastly increased volume of space which now must be kept under surveillance to detect and track unknown satellites is focusing attention on phased-array radar, also known as electronically steerable array radar (ESAR).

Bendix Aviation, under a Rome Air Development Center contract, is building a full-scale phased array radar, scheduled for installation and test near Eglin AFB, Fla., which will become a key sensor in the Air Defense Command's Space Tracking and Detection System (Spadats).

The technique also is replacing conventional rotatable radar antennas in other applications where there is need for extremely high power, long range and/or rapid scanning to justify its higher cost.

For example, the phased-array electronic scan principle is used in the Hughes surveillance radar installed on the new Navy aircraft carrier USS Enterprise. Sylvania is studying the possible application of the technique to the Nike Zeus anti-ICBM radars, under Bell Telephone Laboratories subcontract.

The electronic scan techniques have been under investigation by Bell Laboratories and Sanders Associates for airborne flush-mounted radar. The programs originally were directed toward the RS-70 and the now-canceled F-108 aircraft.

Maxson Electronics Corp. used similar techniques in the passive height-finding radar it developed for the Federal Aviation Agency. Other companies known to be active in the field include General Electric, Radio Corp. of America and Raytheon.

The phased-array electronic scanning technique promises a number of advantages over more conventional rotatable radars both for radar and for communications. In some applications, such as space surveillance, there is little competition from conventional radars.

Precision Questions

There are those who question whether phased-arrays can produce as precisely shaped a beam as the conventional parabolic antenna. A Bendix spokesman concedes that this may apply to some electronic scan techniques, but he says those used by his company can match the beam forming capability of a conventional antenna, except possibly at X-band frequencies and higher where mechanical tolerances become difficult.

The electronic scan technique employs a cluster of stationary radiating elements in a planar array. Each of the excited elements is powered from its own small radar transmitter and has its own receiver.

When the energy delivered to all such elements is matched in magnitude and phase, a fan-shaped beam is produced which is perpendicular to the plane of the array. The width of the beam is determined by the number of elements in the array and the spacing between them. Usually the spacing between elements is about 50 to 60% of the operating wavelength. For an L-band array (1,000 mc.), this spacing is roughly 6 in.

If a method is provided to permit the relative phase of the energy delivered to each element to be shifted by a suitable amount with respect to the adjoining elements, the fan shaped beam will itself be shifted through a corresponding angle with respect to the plane of the array.

By continuously varying the amount of phase shift for all elements, the beam can be made to scan.

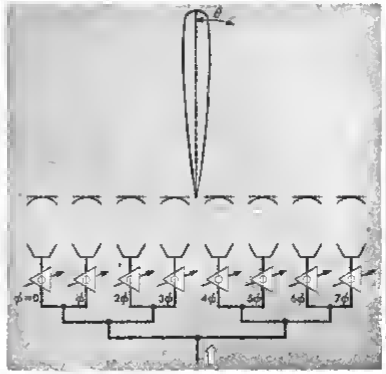
As the beam is shifted from its broadside position, it begins to broaden in its width. The beam broadening is relatively small for angles up to about 30 deg., but at an angle of 60 deg. the beam is roughly twice its original width. (Beam width varies inversely with the cosine of the steering angle.)

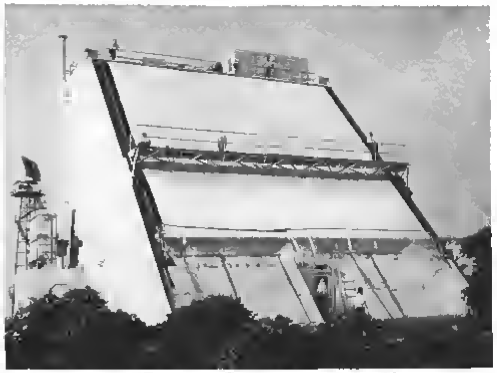
This appears to be an inherent limitation in electronic scan antennas. To scan a full 360-deg. hemisphere requires at least three arrays, preferably four. The Hughes radar on the Enterprise uses four arrays each physically displaced by 90 deg. from the adjoining arrays.

Variety of Techniques

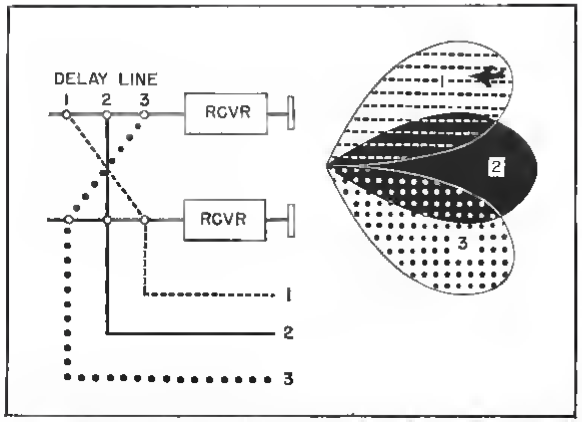
There are a variety of techniques that can be used to deflect the beam. One is to use a ferrite phase shifter between the radiating element and its transmitter-receiver. By varying the voltage applied to the ferrite device, the amount of phase shift it introduces can be varied. Thus the phased-array beam can be made to scan, or to point in a desired direction, merely by applying suitable voltages to each of the phase shifters.

The electronically steerable phased array radar, with the ability to point its beam in any desired direction in a thin-

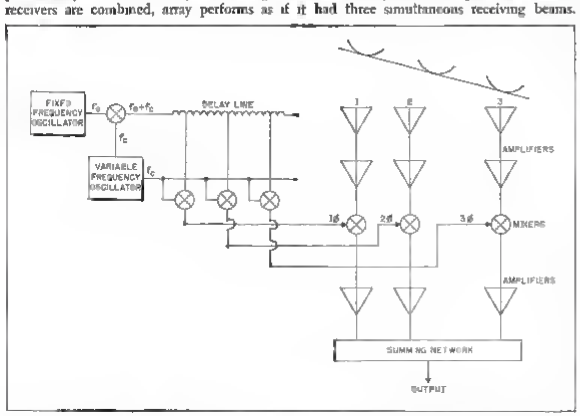




PHASED-ARRAY RADAR, whose beam is aimed electronically, is prototype of larger model being built by Bendix for Air Force's Space Tracking and Detection System (Spadats.) New technique enables radar to track many targets and scan large volume rapidly. Principle of operation is shown in sketch. By delaying arrival of transmitter energy at each of the radiating elements, or shifting its phase, the orientation of radiated wavefront is altered, producing a proportional shift in direction of antenna's beam.



MULTIPLE RECEIVING BEAMS for simultaneous reception of signals at different angles is phased-array radar feature. By introducing suitable time delays before outputs of individual receivers are combined, array performs as if it had three simultaneous receiving beams.



PHASE CONTROL STEERING technique used by Bendix, one of many possible design approaches, is accomplished at radar's intermediate frequency using a multiple-tapped delay line as a reference with two heterodyne mixing circuits. Variation in phase shift is accomplished readily by changing the output of the variable frequency oscillator.

sandth of a second or less, offers several attractive features. These include.

• **Simultaneous search and track.** A single phased-array radar can provide both large-volume surveillance and multiple-target tracking, functions that normally require two or more conventional radars. The phased-array beam can rapidly scan a full volume, then quickly return to bounce additional pulses off any targets of interest to obtain additional tracking data. Where a conventional radar antenna must move slowly enough to remain in position until an echo returns from the target, a relatively long time for targets thousands of miles away in space, an electronically scanning radar can transmit its pulse, quickly shift to illuminate other targets, then return to listen for echos from each. Since the beam direction is controlled by a digital computer, it can be programed to return first to those targets at short range, later to those at greater distance. The beam of the prototype ESAR can be shifted from any location to any other position in approximately 20 microsec.

• **Increased power capability.** While notable advances have been made in peak power levels of radar tubes, the extremely high peak power levels create serious voltage breakdown problems in the tubes, power supplies and transmission lines of a conventional superpower radar. In contrast, the phased-array radar uses a large number of relatively low power transmitters whose power is combined only after leaving the radiating elements. Where the designer of a conventional superpower radar may be limited by unavailability of superpower components, the designer of a phased-array radar has a wide choice of low-level components. To boost radar power levels, it is only necessary to add more elements to the array.

• **Reliability.** In a large-scale phased-array radar which may use several thousand elements, failure of a few individual transmitters or receivers has relatively little effect on system performance, according to Bendix. The company says that this ultimately should give the phased array radar superior reliability. Additionally, because of the large scale quantity production of the transmitter and receiver, whose complexity is comparable to a television set, quality controls can be used which are not applicable to construction of a few superpower equipments.

• **Hardening.** Because the phased-array antenna is stationary, it is easier to provide a hardened installation capable of withstanding nuclear blast forces. Studies conducted by Bendix indicate that a phased array system could be built in a reinforced concrete dome with the array face covered by rugged dielectric covers capable of withstanding severe overpressures.

In 1958, as part of the Advanced Research Project Agency's Project Defender anti-ICBM program, Bendix Radio Division won a Rome Air Development Center competition for a six-month feasibility study of an electronically steerable array radar. The company built a single-axis model containing 90 elements during this period to evaluate problems and demonstrate feasibility.

In January, 1960, Bendix was authorized to design and build a two-axis ESAR demonstration model, operating at L-band, which could be used to track both air traffic and missile launchings from the National Aeronautics and Space Administration's Wallops Island Station in Virginia.

Completed late in 1960, the model has a 50 x 50 ft face with more than 8,000 log-periodic antenna elements. For economy reasons, only 760 transmitter-receiver units were built. These were connected to antenna elements selected to provide essentially the same beam shape and width which would be obtained if all elements were excited, but with some sacrifice in gain and sidelobe suppression.

To reduce sidelobes in the phased-array radar, more powerful transmitters can be used to power the central radiating elements, but this sacrifices the advantage of being able to use standard transmitter units throughout. For this reason, Bendix prefers to reduce sidelobes by leaving roughly half of the antenna elements unpowered and reducing the spacing between active elements near the center of the array, according to K. F. Molz, manager of radar engineering at Bendix Radio Division.

This does not affect the width of the beam which depends only on the size of the array (total aperture). The only disadvantage arising from this approach is loss of power in the unused elements, or less efficient use of transmitter power.

There are a number of different techniques which can be used to achieve the required phasing between elements of the array to steer the beam. One, reported by Lincoln Laboratories, uses a number of delay lines, each with a different time delay. Diode switches are used to select the desired delay line through which the signal passes before reaching its radiating element.

Bendix Method

Bendix prefers another technique, called phase control steering, in which the desired phase relationship is accomplished at the radar's intermediate frequency (IF), using a heterodyne circuit. A multiple tapped delay line is used, but its function is to provide a convenient reference for generating the required phase shift in the heterodyne circuit and not to introduce phase shift directly into the radiated energy, as in other techniques. The magnitude of the phase shift is controlled by a variable frequency oscillator.

Molz says Bendix prefers this technique because the desired phase increments can be applied separately for steering in each of the two dimensions of the array, then combined by mixing to give the precise phase required for each element. Only a single digital input is required for each dimension.

The same technique can be used to shift the phase of incoming signals during the receive mode of operation. Signals received from any point except directly broadside and centered with respect to the antenna array will be received first by elements closest to the target, followed by those at the center of the array and finally by those at the furthest extremity. Unless appropriate phase shift is introduced, any attempt to combine the signals from all elements would result in cancellation for lack of phase coherence.

When the relative phase shift matches the angle between the plane of the array and the target or signal source in space, then all signals will add coherently. Viewed another way, the antenna's "receiving beam" is steered in the same manner as its transmitting beam.

Another interesting capability of the phased-array antenna is that its incoming signals can be combined to create simultaneous multiple receiving beams, each pointing in a different direction.

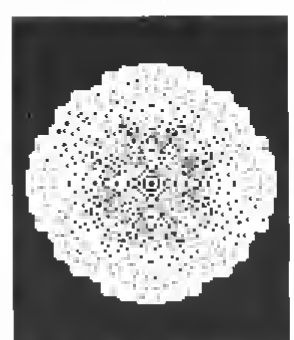
This capability can be used in several ways. One is to create a cluster of receiving beams, all of which are steered simultaneously to find a target whose position is not precisely known.

Target Tracking

Another possible use is to produce the equivalent of a monopulse type radar for tracking, with four (or more) beams, two along each axis to measure simultaneously the relative phase and magnitude of each target echo and provide information on target motion and more precise data on its position.

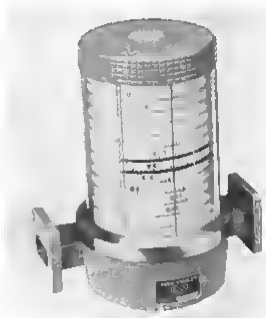
A number of techniques can be used to obtain the multiple receiving beams. These employ various types of networks which introduce known amounts of time delay or phase shift so that signals arriving from several directions simultaneously can be added coherently (see sketch). The technique which Bendix employs, called post-amplifier beam forming, first amplifies the incoming signals, after which they enter resistive type summing networks which introduce the required time delay to permit them to add coherently.

Military security restricts Bendix from discussing techniques to be used on the new Air Force Spadats electronically steerable radar. However, it is reasonable to expect that it will use many of the same concepts employed on the L-band demonstration model at the company's plant in Towson, Md.



PROTOTYPE Bendix phased-array radar has 8,000 antenna elements, but only 760 of them are excited to hold down construction cost. By judicious choice of excited element location, and closer spacing near center of array, prototype achieves performance comparable to fully excited array except for sidelobes and gain. Darkened areas indicate excited antenna elements.

NEW AVIONIC PRODUCTS



• **Direct reading frequency meter,** Model X1301A, can read frequencies from 8.2 gc to 12.4 gc with over-all accuracy of 0.08%. Meter uses TE_{m} resonant cavity coupled to WR 90 waveguide with dip of approximately 1 db in transmitted power at resonance. Price is $157.50 with delivery from stock. Manufacturer of the meter is Budd-Stanley Co., Inc., 175 Eileen Way, Syosset, N. Y.

• **Cathode ray tube,** PX 275, designed for direct electrostatic printing, has a target mosaic instead of phosphor screen, comprised of patterned one-mil-dia conductive elements spaced on four-mil centers to form printing 7¾ in. long by 150 mils high. The conductive elements permit electrons to be transferred from the tube beam to the printing medium. Electrostatic charge built up on the medium is made visible by utilization of a pre-charged pigmented powder. Manufacturer of the cathode ray tube is Electron Tube Division, Litton Industries, 960 Industrial Rd., San Carlos, Calif.

• **Microwave oscillator,** Model G120 designed as stable local oscillator and transmitter signal source for high resolution radar systems on ships, is continuously tunable over the 8.5 gc to 9.6 gc range with dial accuracy of ± 0.01% calibrated in one mc increments. Short-term stability is 2 parts in 10⁸ (nominal) and 5 parts in 10^{8} max. Long term stability is 1 part in 10^{5} for 8 hr. Power output is 500 milliwatts/mm with a stability of ± 1 db. Price is $13,000. Manufacturer of the oscillator is Frequency Engineering Laboratories, P. O. Box 504, Asbury Park, N. J.

More Weapons Inspection Funding Urged

By C. M. Plattner

New York--Funding for research and development of disarmament inspection equipment and techniques similar to funding already allocated for developing military reconnaissance systems is being urged by Trevor Gardner, a member of President Kennedy's Disarmament Advisory Board

Scientific disarmament effort is needed, including a series of inspection experiments, so that inspection guidelines can be based on facts, Gardner told the Society of Photographic Instrumentation Engineers recently at a national symposium here

Gardner, who is president of Hycon Manufacturing Co, Monrovia, Calif, said, at the same time it is necessary to develop new equipment, theories and techniques of inspection through increased research and development programs

Technical Aspects

Since there has been no substantial scientific investigation of inspection problems until recently, the technical aspects of inspection systems are only partially understood he said

For developing criteria to ensure treaty agreements are preserved, Gardner suggested employing a wide variety of verification techniques in peace gaming

This is similar to the military practice of war gaming where policies and equipment are tested and improved through actual usage

Peace gaming is necessary, in Gardner's opinion, so that a probability of success can be assigned various types of treaty verification techniques Feasibility of non intrusive types of inspection can then be established

In gathering information on whether disarmament agreements are being kept, Gardner advanced a "matrix of indicators" concept, or the utilization of a full range of data gathering techniques, including aerospace systems This concept requires rapid and accurate communications central data handling and processing, and easy control of the inspection force, he said

Violation Detection

Matrix of indicators data he said, when correlated against both the declarations of the inspected country and other available national intelligence information should provide greater treaty violation detection data than other methods

Many analysts believe the matrix of indicators approach will permit minimum intrusion while providing maximum information on the reality of disarmament risks, Gardner told the symposium engineers.

For future verification techniques, satellites appear to hold the greatest promise. They could provide secure communication links between inspection teams, control centers and heads of state, Gardner said Such satellites could be operated for both general and specific coverage and for global surveillance purposes

Aerospace inspection techniques and reconnaissance are an especially valuable tool, said Gardner, since they are capable of greatly reducing ground inspection and the intrusion that this type of inspection entails

Utilizing high altitude photography and either low altitude reconnaissance or ground inspection, depending on need, will reduce the necessity for heavy dependence on ground inspection alone, Gardner said A large amount of accurate and detailed data can be gathered in any limited area, he added, with existing reconnaissance equipment and a few high performance aircraft and helicopters

V STOL aircraft also can play a versatile role in future inspections, with their capability of landing hovering or flying at high altitude for surveillance or verification utilized, according to Gardner

Along with better data acquisition capabilities, Gardner indicated that special purpose sensors and communications will probably be developed for future use

Both ground based and airborne processing centers using existing and new equipment in communications, data processing and data matching with command and control capabilities, will be needed according to Gardner

Regardless of the data acquisition techniques used, Gardner said, certain unusual conditions will prevail due to the exact nature of the disarmament problem

List of Conditions

He listed these conditions

- **Desirability** of maximum data acquisition for minimum intrusion
- **No hostile action** as in wartime reconnaissance
- **All weather capability**
- **Urgent time requirements** for detection of early mismatches of data
- **Problems in simplified command** and control for local verification teams
- **Complexities with secure communications** for verification teams

In referring to U S-USSR disarmament negotiations, Gardner said, "The rigid test national security forces upon us is that the amount of inspection should be proportional to the risk from concealed or undeclared forces." He distinguished between this approach and another thesis, which has been gaining increasing credence from extensive usage in U S-USSR treaty discussions--that the amount of inspection or intrusion should be proportional to the amount of disarmament achieved

Popular conception of inspection and control in maintaining a disarmament treaty is that of ground inspection by on-site personnel, Gardner said This is also the most intrusive and its nature makes closed societies like the USSR reluctant to accept it However, he added, the option to make such on-site inspections greatly increases the mathematical probability of treaty violation detection

Ground Teams

Ground inspection teams, when used, would generally look for indications of nuclear devices, missiles, aircraft, submarines ground forces material, and anti-ICBMs In addition, he said, ground inspections could also verify the number and deployment of military forces and armaments, indicate military research and development, and verify major transportation, command and control centers

In Gardner's opinion, however, it seems probable that physical inspection could not reveal carefully hidden striking forces particularly nuclear stores, which might be hidden in the 14 million square miles of the Soviet Union and its satellite nations.

Psychological Inspection

To offset this possibility, Gardner suggested a consideration of the area of psychological inspection. He named the following which require study in evaluating this technique

- **Application of normal police methods** such as reliance on personal interviews or reports
- **Inspection of national budgets** of the nations to be inspected.
- **Reporting and verification** of activities and travel of key scientific, military and executive personnel
- **Study of lie detector methods** and development of additional instrumentation in this field
- **Value of negative controls**, such as providing premiums for "tips" and use of national postal systems in connection with this plan

Establishing a high confidence level for one or more of the above techniques could make physical inspection of disarmament simpler and more reliable, said Gardner

Exploratory FAA Tests Completed On U.K. Automatic Landing System

Bedford, England—Federal Aviation Agency has completed exploratory evaluation of the British Autoland System here, using a specially equipped Douglas DC-7, and plans to accelerate the investigation at the National Aviation Experimental Center, Atlantic City, N.J.

The FAA DC-7, purchased from American Airlines, has made 310 completely automatic landings at Blind Landing Experimental Unit (BLEU) here, but scatter rate and final data will not be collated for some time.

System, developed by BLEU with Royal Aircraft Establishment funding, has been primarily designed for Royal Air Force V-bombers and Argosy 660 transports, the de Havilland Trident and the Short Belfast.

Sud Purchases

In addition, simplex and multiplex versions have been sold to Sud Aviation, of France, for evaluation in the Sud Caravelle at Toulouse. Considerable interest in fitting Autoland to propeller aircraft in the cargo field has been shown in the U.S., mainly by American Airlines.

The agency first contracted for Autoland early in 1961, with Smiths Aviation Division, but specified use of the Sperry SP-20 autopilot, rather than the Smiths unit, a rate gyro mounted on a platform. Because the SP-20 is a vertical gyroscope, the Smiths modification resulted in a "pseudo platform," into which the usual Autoland signals could be fed.

Pseudo platform inputs include in-flight data from the Murphy leader cable receiver, Standard Telephones radio altimeter, the ILS localizer and the DC-7's compass.

Another problem involving use of the DC-7 arose from installation of radios for leader cable inputs. Previous systems installed in BLEU de Havilland Comets, the V-bombers and a Vickers Varsity had been mounted in the nose section.

Since the DC-7 is fitted with weather radar, an alternative position had to be found and one, near the center of gravity, proved unsatisfactory because of reflections when the landing gear was lowered.

Computer Study

However, Smiths decided to run a computer study, based on data supplied by Douglas Aircraft, and the end result was development and installation of a tail aerial. Flight trials have borne out computer predictions, according to Peter Smith, company project director who has been assigned as Smiths liaison officer during the FAA trials at Atlantic City.

The agency does not consider BLEU equipment, as mounted in the DC-7, as a system, according to R. F. Link, chief of the FAA European Aviation and Research Development Service, stressing "it can only become a system by addition of other elements in such a manner that it is made to represent an operational model."

Single, automatic channel, he added, is not directly adaptable to IFR operations without supplemental features to assure high level of performance for civil carriers.

Part of the FAA exploration into a final configuration will include multiplexing, and research into tandem use with the Smiths Para-Visual Director (PVD), a "barber-pole" device to feed flight attitude information to the pilot while he looks outside the cockpit (AW July 11, 1960, p. 83).

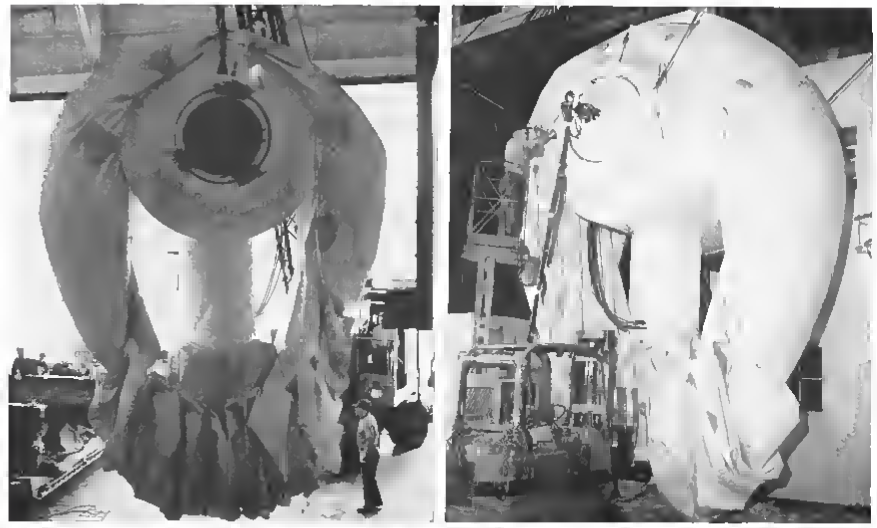
As Link put it, FAA intends to make "maximum use" of the pilot in controlling and monitoring the approach, landing and roll under blind conditions. Resultant information will be applied to definition of the exact role of automatic equipment in combination with human inputs during the entire operation, with particular regard to the degree of reliability that can be obtained.

FAA also aims at developing ILS waveguide localizers to an acceptable level of performance, although initial tests involve use of the Murphy leader cables now installed at the NAFEC installation.

DC-7 Equipment

The DC-7 equipment includes automatic throttling to maintain airspeed, but modified into two input streams for safety reasons. One controls outboard engines and the other the inboards. If a failure occurred in one, the loss of power thus would be symmetrical. Comparator also monitors the system for automatic disconnect and pilot warnings.

Smiths Aviation Division has a complete simplex system in production for Royal Air Force. Duplex autoflare will be provided in Trident three-jet transports for British European Airways with full provision for duplex blind landing available if required. Triplex system will go into service with the Short Belfast turboprop transport for RAF. Duplex system for the Vickers VC-10 is being designed by Elliott Bros. around the Bendix PB-20D autopilot (AW Jan. 22, p. 67).



GOODYEAR'S 30-ft. inflatable station was erected at Lewis Research Center as part of NASA youth day space exhibit.

Goodyear Builds Inflatable Space Station

By Arnold Sherman

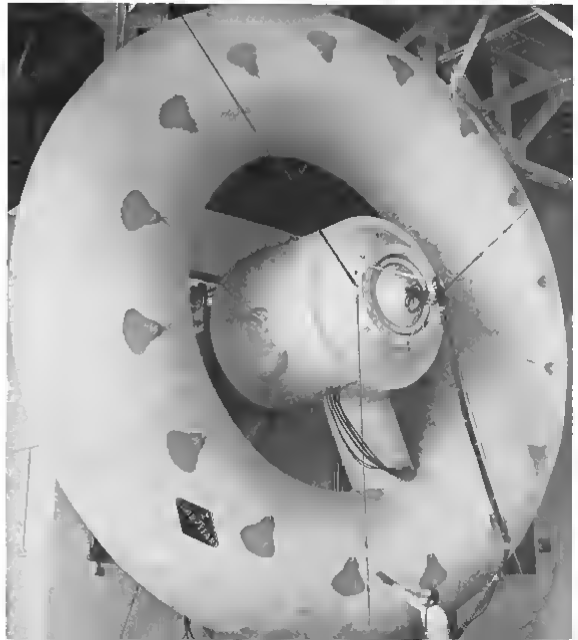
Cleveland—Goodyear Aircraft Corp. is investing its own funds in a 30-ft. experimental inflatable space station which is an outgrowth of an earlier 24-ft. inflatable torus currently being evaluated by the National Aeronautics and Space Administration.

Goodyear's earlier, doughnut-shaped model is undergoing tests at NASA's Langley Research Center, Hampton, Va. The 24-ft. inflatible torus is being utilized in a NASA program to ascertain variable gravity effects and to determine the best methods of folding, deployment, erection, ventilation and maintaining an 8 psia atmosphere environment (AW June 26, 1961, p. 93).

With NASA striving for an operational space laboratory functioning before 1970 (AW July 2, p. 210), Goodyear officials are intent upon pressing their program despite no added official assurances from NASA. They believe that if the Langley model checks out satisfactorily, their inflatable space station concept will put them in a good competitive position for future space station bids.

The 30-ft. model, unveiled at Lewis Research Center recently, represents an expenditure of several hundred thousand dollars and carries the Goodyear inflatable concept from the simple torus being gravity-tested at Langley to a space

INFLATED torus is shown with only one spoke. Addition of three more is envisaged.



station which incorporates spokes connecting the hub to the torus for added stabilization and for entry and egress access into the station during rendezvous docking according to Goodyear Aircraft President T. A. Knowles.

Knowles emphasized that the 30 ft model, consisting of a neoprene coated Dacron torus, a metal canister-shaped hub 12 ft in length and 8 ft in diameter and spokes connecting the hub to the torus is merely a step toward an eventual inflatable space station which would be 150-200 ft in diameter. Mission requirements and the human factors element would dictate exact size criteria, according to the company.

Station Weight

The over-all weight of the 30 ft model is 1,800 lb. The 150-200 ft model would weigh between 15,000-16,000 lb., according to S. J. Pipitone, manager of astronautic engineering. The larger model would accommodate all required life support systems in addition to 3-10 occupants, according to Pipitone.

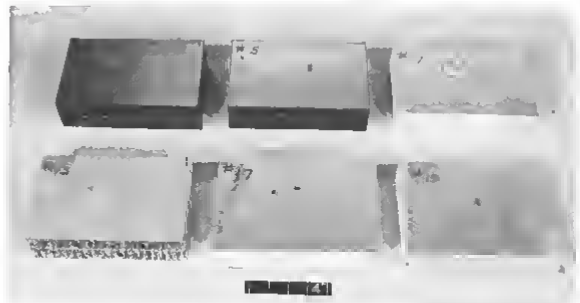
One of the knottiest problems indigenous to the program is whether the tire-tube shaped station will be able to withstand expected micrometeoroid pummeling in space. According to Pipitone, Goodyear envisages protecting the torus with 1-2 in. thick foam layer. During tests, pyrex pellets ⅛ in. in diameter were fired into the foam at velocities ranging from 16,000 to 20,000 fps. According to Goodyear, the foam rubber provided protection comparable to rigid types (e.g. aluminum) of similar weight. However, once in space, the micrometeoroid bombardment will occur at speeds ranging from 80,000-120,000 fps. and whether the non-rigid skin can sustain a continuous bombardment at those speeds is something that will be answered only if the station is actually lofted into space.

Radiation Shielding

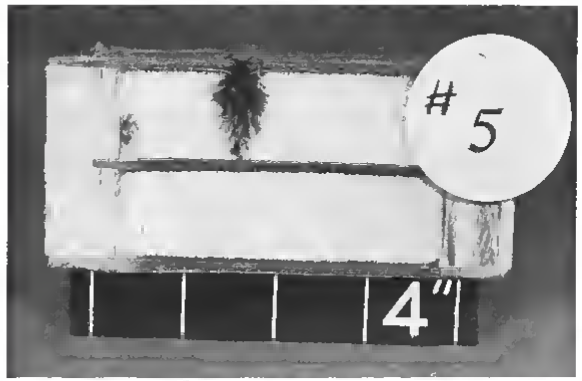
Pipitone told AVIATION WEEK that Goodyear doesn't plan any heavy radiation shielding for the satellite. "We expect the space station will be lofted into an orbit between 200-500 mi. from the earth. Since the 500 mi. apogee would keep the station below the dangerous radiation of the Van Allen belt, heavy shielding isn't required."

Questioned about the life expectancy of the Goodyear station, Pipitone said that there was no time limit on its operational capability. "As far as we're concerned, the station will have a permanent life expectancy."

Goodyear stresses that one of the major advantages inherent in the inflatable space system concept is ease of packaging. The torus is packed around the central hub during lift-off, thereby



SIX SAMPLES are shown of meteoroid impact tests conducted by Goodyear. Panel 1 consists of 2 skins of Dacron covered with butyl rubber, with foam spacer between the fabrics. Number 5 is composed of 3 walls of Dacron fabric, with butyl rubber covering. Section 7 is composed of two walls of aluminum sheet. Number 13 shows three walls of crushed honeycomb, separated by a 1 in. honeycomb spacer. Panel 17 shows two walls of crushed honeycomb separated by foam and 19 consists of three walls of crushed honeycomb and a foam spacer. According to Goodyear, tests (firing pyrex bullets into materials at between 16,000-20,000 fps.) indicated that fabric fared no worse than rigid structures.



CROSS-SECTION of penetration of Dacron fabric is shown. In the Goodyear tests none of the materials used, inflatable or rigid material, indicated penetration to back wall.

reducing drag and instability that might be anticipated from rigidized stations during the launch phase.

Automatic Expansion

Once the station is inflated in its predetermined orbit it would be expanded automatically by the life support air being forced into the torus. "Thereafter, the air conditioning system would draw, as required, on the oxygen and nitrogen supplies stored in pressure containers in the metal hub," according to Knowles.

By rotating the station once in orbit, Knowles said an artificial gravity could be achieved. "This would be accomplished by using compressed gas or solid propellant jets on the periphery of the rubberized ring." Larger versions could simulate earth gravitation inside the torus, according to Goodyear. The metal hub, which is utilized for rendezvous docking entry and egress and for experiments requiring no gravity, would remain essentially at zero-g.

Solar Power

Knowles said that power for the space station would be generated by solar energy. An inflatable solar heat collector would be deployed.

All furnishings in the station would be rubber. Bunks, tables, desks and chairs would be constructed of two plies of fabric hooked together by nylon cords to give the furniture form and rigidity.

NORD SUPER BROUSSARD MH-260, being built in France in 10 airplane lot, is powered by two Turbomeca Bastan IV turboprops. Engines have overhaul life of 750 hr. which is expected to go to 1,000 hr. Wingspan is 71 ft. 11 in., length 59 ft. 2 in.

Aviation Week Pilot Report:

Nord Pushes Super Broussard Production

By Herbert J. Coleman

Paris—Nord Super Broussard, a no-frills twin-turboprop transport aimed at the Douglas DC-3 replacement market, has a high degree of performance—particularly in single engine operations—in no way compromised by a design aim of simplicity and low cost.

Now approaching the end of its certification trials, the Super Broussard (designated MH-260) will first go into service with the French internal airline, Air Inter, to gain route experience this fall.

In the meantime, Nord Aviation is pushing production of 10 MH-260s while at the same time accelerating development and production of the pressurized MH-262 version for a first flight at the end of this year.

The double-barrelled development program is unique in that the MH-262 is Nord's hope for extensive world sales. Nearly all airline interest in the airplane and there is considerable, has centered on the MH-262 which, along with its predecessor, is heavily backed by the French government.

Nord, however, is convinced that the 10 unpressurized Super Broussards will be heavily utilized by customers who wish to gain route experience while waiting for delivery of the MH-262 version. All 10, Nord officials said, will be available for lease or outright sale, with arrangements available for trade-in on the MH-262.

Three MH-260s now are flying in the certification program. Deliveries of the MH-262 are scheduled for the second quarter of 1963 with production program aimed at rollout of four per month by the end of that year. The airplane is being built at Nord plants at Bourges les Mureaux, Meaulte, and at the Rheims facility of Rheims Aviation, formerly Societe Nouvelle des Avions Max Holste original designers of the Super Broussard.

First Buyer

First buyer of the pressurized MH-262 is the Norwegian airline Wideroe's Flyveselskap, which will put two in service in the fall of 1963, on a variety of missions including survey and photographic work.

Simplicity of design and relative ease of maintenance has generated interest from airlines which normally operate in rugged conditions such as the Australian bush (AW Nov. 13, p. 47; Nov. 27, p. 46) and Alaska. Nord has also talked with the Portugese airline, Transportes Aeros Portugueses (TAP) and the Portugese air force. A number of African nations also have looked at the airplane.

Initially, Nord is concentrating its sales effort on use of the Super Broussard as a feederliner, without ignoring its obvious military potential. Possibility of a French air force order, however, is remote since the government is backing the Dassault Spirale 3 turboprop.

In addition, Nord indicated it would consider license production, particularly in the United States. Price of the MH-260 is $260,000 and Nord estimates a complete navaid and radio package would cost about $35,000 more. Nord has not yet announced the price of the pressurized MH-262, but it probably will be about $400,000 completely equipped.

Airplane flown by this AVIATION WEEK pilot was the No. 2 MH-260, F-WKRB. Pilot in command was Nord Test Pilot Armand Gacquet, with development chief M. Kaplan also aboard.

Interior fittings were spartan, with the usual 23-passenger tourist seating arrangement modified to allow fitting of flight test instrumentation. Cockpit is roomy, however, and visibility, both taxiing and in-flight is remarkably good for a high-wing airplane, since the pilots sit well ahead of the wing and the two Turbomeca Bastan 4 turboprop engines.

Installation of the Bastan 4 engines has been kept deliberately simple to facilitate changes, both in speed and rugged conditions. Each engine is attached to the mounting at three points, and all connections are specially fitted in order to reduce removal time to a minimum.

Each Bastan 4 produces 986 ehp and drives Rotor-Figeac three-bladed propellers. The engine has an axial compressor, followed by a centrifugal compressor, and an annular combustion chamber into which fuel is injected by centrifugal means. The centrifugal compressor and three-stage axial flow turbine are mounted on a common shaft coupled to the axial compressor.

Pressurized Version

The pressurized version, however, will be fitted with Bastan 6 turboprops, uprated to 1,065 ehp. Engines now are on test stands and will fly when the MH-262 makes its maiden flight. Fuel consumption at cruise power has been cut to 503 lb./hr., against 524 lb./hr. for the Bastan 4. Tailpipe temperature of the Bastan 6 at cruise, is 430C, against 420C for the Bastan 4.

Spacious cockpit was fitted with dual controls but could be offered with single controls only, at customer requirement. Engines are controlled by two levers, one to select rpm and the other to determine fuel (throttle), with the latter incorporating a fuel cutoff in the extreme aft position.

Starting also is simple and the sequence merely requires that the master switch, internal batteries and boost pumps be on before the starting button for the starboard engine (No. 2) is depressed.

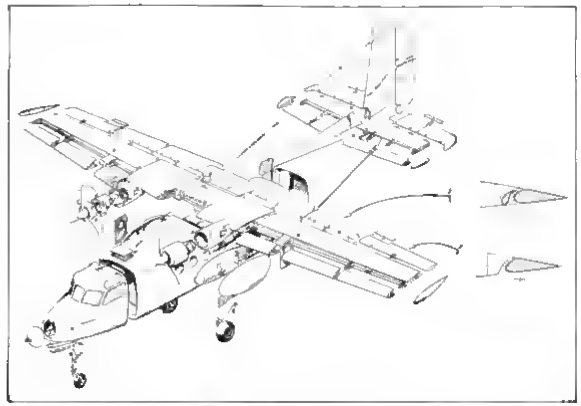
Generators are switched on after lightup, and the airplane is ready to taxi. Rpm lever is set for 90% rpm and the props are automatically pitched to produce thrust for taxi.

Normal takeoff is made at 101.5% rpm., or 33,500. Power instrument is a dual gage which reports the ratio of compressor inlet to outlet pressures. Pitch stops on the central console are feather, flight coarse, and ground fine and coarse.

Designers also have included, as an additional safety feature, an automatic feathering system, in case of thrust loss, pitot heads sense pressure differential behind the propeller and puts the system into operation.

With the wide main gear spacing, and low profile, the Super Broussard can be taxied and turned at quite high speeds with little adverse reaction by passengers. For this flight, the plane was flown at a weight of 11,940 lb. and its flight reactions were in proportion to the Super Broussard's handling at its maximum takeoff weight of 21,605 lb.

Ceiling was about 400 ft., complete overcast, and visibility about 2 mi. at



EXPLODED DIAGRAM of main and subassemblies of the Super Broussard MH-260 emphasize degree of interchangeability. Components thus utilized are the wing center section, outer wing panels, horizontal stabilizer and fin and control surfaces and wing flaps.

NORD AVIATION is pushing MH-260 production while at the same time accelerating development of pressurized MH-262 version.

takeoff. With power set at 101.5%, acceleration was rapid and rudder control highly effective shortly after initial movement. Rotation and takeoff were simultaneous at about 83 kt. and, with gear retracted, the instrument climbout was set at 120 kt., in a rather steep attitude, considering lightness of the load.

We broke out of the overcast at about 6,000 ft. and were cleared to maintain 8,000 ft. Drooping nose and new windows cut into top of the pilot's compartment give excellent visibility in the cruise regime. Interior noise level at 185 kt. cruise speed is not uncomfortable, but it was found more convenient to use the pilot's intercom for crosstalk in the cockpit.

The Super Broussard handling characteristics show a high degree of responsiveness. In fact, again considering the light weight, it can be put into unusual operating conditions with a minimum of effort, and recovery is just as fast. For instance, a turn, at 185 kt. from straight and level to 30 deg. bank can be accomplished with little effort and without the heavy back-pressure usually needed to maintain cruise altitude in such a position. Rollout reflects the extreme responsiveness of the ailerons.

Stability of the Super Broussard again was evident in the engine out regime. In clean configuration, gear and flaps up, Gacquet feathered No. 2 engine with no warning and, with exception of a slight yaw, the attitude changed little. Airplane can be turned steeply into the dead engine and, with judicious use of trim, can be flown quite easily.

Still in clean configuration, and with No. 2 Bastan restarted, the airplane was put into a power off stall, payout came at about 65 kt., accompanied by a slight buffet which came after the warning horn (75 kt.). Left wing dropped gently and recovery was made in less than 100 ft. With power on, and in nose-high stall attitude, the Super Broussard could be slow-flown almost indefinitely. Controls remain quite active even during the stall, particularly the rudder action.

With gear down, and the double-slotted flaps set for landing, throttles were gradually reduced as the nose lifted and gear lowered. Stall warning, which is heard in the pilot's headset, sounded at about 65 kt. and, following a more pronounced buffet, the airplane stalled out at about 50 kt. Reaction again was similar, with a dropoff to the left and a gentle turn.

Returning to land, we obtained a GCA letdown and made the traffic pattern at about 850 ft. since the ceiling had lifted somewhat. The Super Broussard was flown at 120 kt. downwind when gear was lowered and approach flaps set at 15 deg. Landing flaps were selected in the final approach and speed stabilized at about 85 kt. Glide angle feels steep to a pilot new to the airplane and the flareout started late, because of this factor. However, landing was accomplished with little difficulty, due mostly to some help by Gacquet and the ease with which the low pressure tires meet the runway.

On a second landing, with final flown at the same speed, but in a flatter angle, the Super Broussard touched down on the first third of the 8,000 ft. runway, at which time Gacquet demonstrated the powerful braking action, cutting the landing roll to a few hundred feet.

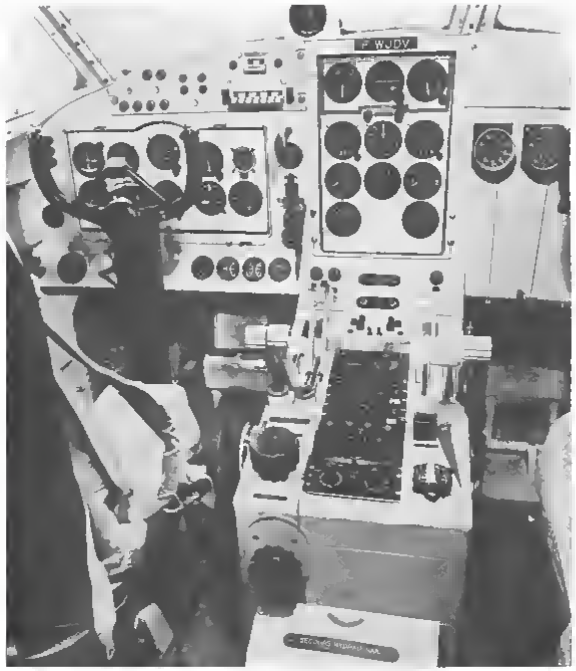
Kaplan later explained that the low pressure tire system (45.5 lb./sq. in. on the main wheels and 43 lb./sq. in. on the non-steerable nose wheel) was chosen in view of the Super Broussard's potential use from rough surfaces. Gear retracts into side fairings which, on the starboard side, also house the air conditioning unit.

Nord has designed the Super Broussard to carry 17 first class passengers, or 23 in tourist configuration. A third option is mixed passengers and freight. Toilet and baggage compartment are located in the aft section.

The pressurized MH-262 will have a number of design changes, including a cylindrical fuselage, revamped nose section and tail section which eliminates the distinctive dorsal fin of the MH 260.

Certification of both aircraft have been aimed at requirements of French Air 2501 specifications and the U.S. SR 422. Pressurized version will be made available in executive layout with 12 to 13 seats in a variety of positions. A movable bulkhead also will allow cargo-passenger adjustments.

Specifications for the MH-262 Super Broussard are: empty weight, 12,361 lb., basic operating weight, 13,367 lb., maximum takeoff weight, 21,715 lb., maximum landing weight, 20,720 lb., zero fuel weight, 20,500 lb., and maximum payload, 7,750 lb. Cruise speed will be 208 kt., rate of climb at sea level, 1,620 fpm. and service ceiling 30,200 ft. Wing area is 592 sq. ft., with an aspect ratio of 8.72 and wing loading of 36.6 psf.



ENGINE INSTRUMENTS on Super Broussard are grouped in standard pattern in center panel. Cockpit shown here is fitted for two-pilot operation, with double sets of throttle and pitch control levers. All radio gear is grouped on main console, between the throttles.

WHO'S WHERE

(Continued from page 23)

Changes

Craig Nunan, manager, Radiation Division of Varian Associates' Equipment Group, Palo Alto, Calif., succeeding **Dr William McBride**, now manager, Electronic Products Division. Also **Patrick Dorney**, manager, Vacuum Products Division.

G. J. Rauschenbach, marketing manager, Ford Motor Co.'s Aeronutronic Division, Newport Beach, Calif., succeeding Roy P. Jackson (AW July 23, p. 15).

Richard B. Bean, European area manager, Product Support Organization of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., with offices in Paris, France.

K. O. W. Crooks, chief engineer, Rolls-Royce of Canada Ltd., Montreal, Canada.

Lt. Col. William J. Hogan (USAF, ret.), Washington (D.C.) regional manager for international activities for Raytheon Co.

Edward J. Deslauriers, Washington, D.C., representative for Lockheed Propulsion Co., a subsidiary of Lockheed Aircraft Corp.

John W. Lasater has joined the engineering staff of Weber Aircraft Corp.'s Aircraft Division, Burbank, Calif., to activate Value Engineering.

Charles C. Goodrich, head of the newly established Houston, Tex., office for Douglas Missile and Space Systems Division. Frank L. Dickey succeeds Mr. Goodrich as Douglas MSSD representative in Huntsville, Ala. Also, **R. C. Emmons**, Douglas MSSD representative in Dayton, Ohio.

Edmond M. Jacoby, European public relations representative for North American Aviation, Inc., with headquarters in Geneva, Switzerland. **James H. Higgs** succeeds Mr. Jacoby as Eastern public relations representative in Washington, D.C.

Dr. Lawrence E. Merteas, staff scientist, RCA Service Co.'s Missile Test Project, Patrick AFB, Fla.

H. C. Rogers, chief test pilot, Aero Engine Division, Rolls-Royce, Ltd., Derby, England, succeeding **A. J. Heyworth**, now appointed to Engineering.

Stanley Gibbs, application engineer, Torrance (Calif.) Facility of the Aerospace Division of Vickers, Inc., division of Sperry Rand Corp.

Gordon S. Mills, director of systems and procedures, American Airlines, Inc.

Beryl L. Boatman, assistant manager, Oceanics Division, Aerojet-General, Azusa.

Arnold Kotz, senior planning officer, Federal Aviation Agency's new Office of Policy Development.

Robert W. Graham, senior site director, installation of Project 465L (new command control system, Strategic Air Command headquarters) for International Electric Corp., Paramus, N.J., a subsidiary of International Telephone and Telegraph Corp.

Dr. Peter M. Kelly, associate director, Philco Scientific Laboratory, Blue Bell, Pa.

Ronald L. Bentley, administrative manager, Instrumentation Division, Microdot, Inc., South Pasadena, Calif.

Morris G. Watson, manager, Communications Department, Melpar, Inc., Falls Church, Va.

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Grumman Goose, asking $10,000.00, ferry-able, needs work to recondition. No radio, has original wings, Goodyear disc brakes, L/E 925, R/E 350. Dean Franklin Aviation Enterprises, 3923 N.W. 24th St., Miami, Fla.

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AVIATION WEEK, AUGUST 20, 1962

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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LETTERS

Market Expansion

In answer to your editorial on "Expanding the Airline Market" (AW July 30, p 11), there are a few comments I would like to make

The article looks at two sources of business One is the businessman or technical man, he does not have to be sold on air line transportation Competition makes him use the airlines whether he likes them or not

The other source mentioned is the family The family will never travel by air No man with several young children is going to take them anywhere by air, as long as the family car is available You could never carry baby formula equipment baseball bats, bicycles rubber boats, dogs, etc, etc by plane The whole concept of entire families traveling by air is impractical within the existing economic system

However, there are vast untapped air travel markets not even mentioned in your editorial

There are many old aunts, uncles grandparents, etc, who like to visit their younger relatives, most such people are afraid to travel by air but once they start traveling the airlines they will never change I have a couple of old aunts who never travel any other way It took a lot of persuasion before they made their first flights

There are millions of such people this is a vast market Of course expense works against it, so I say to the airlines—keep your fares down

Another market is the weekend vacationer There are many couples who like to go to New York to see a show More combinations are needed, i e, fare, hotel room and theater tickets for one price

These two markets alone, once they catch on, will more than fill the empty seats if prices are low enough More coach fares would help Reservations are a nuisance Once the coach catches on it will be the standard means of travel between major cities

James H Owens, Jr
Ann Arbor, Mich

Your editorial "Expanding the Airline Market" (AW July 30, p 11) interested me until the figures began to flow just a little too loosely

In the next to the last paragraph reference is made to 13 5 million families each having an 'after-tax (personal) income in excess of $7,500" Then we are told to deduct $5,000 living expenses and reduce the balance by 50%

Then the editorial says "We find that these 13 5 million families have a total of $48 billion of 'discretionary' funds " I am not much of an economist but my simple arithmetic gives a different result

(7,500 — 5,000) X 0 5 X 13 5 X 10^6 — 1 25 X 13 5 X 10^9 — 16 9 billion

I have reached an entirely different conclusion concerning the present plight of the airlines I travel perhaps 20,000 mi per year on business; almost all by air I make very few transcontinental trips I am based in Syracuse and the usual requirement involves a round trip to Chicago, Washington, New York Cleveland St Louis, etc, say 400 or 500 mi average Since the advent of the "jet age" my travel has become much less convenient The larger equipment has actually slowed down air travel for a variety of reasons

1 Fewer departures
2 More time wasted at the gate and in baggage handling
3 More time on the ground for en route fueling
4 More delays in taxiing and in holding on the ground and in the air due to traffic
5 Larger airports further from town result in more ground time and terrific inconvenience in getting from terminal building to gate, or from one airline's gate to another O'Hare and Idlewild are impossible and are to be avoided by any time conscious traveler Need I mention the 90 min minimum for making a connecting flight?

There is a little airline I believe called TAG which operates from Cleveland Lakefront Airport to Detroit If they were to expand their operations and operate between Cleveland, Lakefront and Chicago, Meigs Field why would anyone making the trip ever go near Hopkins or O'Hare?

I contend we have gone too far in the direction of large complicated high performance aircraft and need now to concentrate on smaller aircraft, smaller close-to-down town airports and more frequent bus-like air service I applauded mentally on reading in Aviation Week of the gains being made by the "third echelon" operators (AW July 23, p 28) using light twin Beeches and Aero Commanders If the inconveniences associated with the use of large fast aircraft and sprawling airports increase much further, I would predict that the trunkline airlines will lose more and more business to the third echelon charter service and personal aircraft

E P Palmatier
Senior Consultant
Development Department
Carrier Research and Development Co
Syracuse, N Y

(The Aviation Week editorial consisted of excerpts from a statement of Harvard Professor Paul Cherington for the Connecticut General Life Insurance Co Flight Forum For the full text and transcript of a discussion of the statement by air transport industry leaders, inquiries may be addressed to the Flight Forum in care of Edward T Chase, 260 Madison Ave, New York 16 N Y.—Ed)

Rockets for Records

After reading the article on the new world speed record set by the Soviet Union (AW July 23 p 25), I was once again perplexed by the failure of the United States to utilize auxiliary rocket engines in its combat aircraft A 6,600 lb thrust rocket motor was largely responsible for the twin turbojet Flipper attaining an average speed of 1,860 mph during one leg of the speed run A similar propulsion system aided the E 66 Fishbed in establishing the world altitude mark of 113 800 ft For other examples of this type of powerplant one need only recall the Napier double and triple Scorpions or the SEPR 841 employed in the Dassault Mirage

The paradox of this situation is that such an engine exists, and was developed by Rocketdyne under the auspices of the U S Navy The AR 1 and AR 2 series of liquid-propellant auxiliary rockets eliminated with a version capable of providing variable thrust from 3,000 to 6,000 lb with a rimming time of seven minutes All models have stop and re-start capability One of these installed in a F 86FK gave it supersonic speed in level flight, reduced its turning radius by 50%, gave it a ceiling of over 60,000 ft, and a rate of climb above 40 000 ft 15 times greater than that of the standard F 86F

For some reason we have failed to exploit the advantages inherent in a jet and rocket powered aircraft Such an engine employed in the F 106 presumably our last interceptor would provide spectacular high altitude performance which would be of great assistance in coping with the new generation of supersonic Russian bombers The B 58 A3J F 105 as well as most other air vehicles in our arsenal could also benefit considerably from further improved versions of this powerplant The now defunct F8U-3 was the only plane in this country designed specifically to include an auxiliary rocket in its propulsion system

Our civilian policy makers must be made to realize that one nation cannot arbitrarily decide that further developments in manned aircraft are not required, be it in the realm of an auxiliary rocket engine, a Mach 3 bomber, or a nuclear-powered airplane

Jim DiGiacomo
Fair Lawn, N J

Phantom's Shadow

On p 42 of Aviation Week of July 30, Mr Booda states that the Phantom 2 is able to turn a smaller circle than any other U S supersonic fighter with the help of boundary layer control Being in the "fighter business" I feel that he is mistaken If he is able to back up the statement I would appreciate to see his data I feel extremely confident in saying that the F8U (any model) would have" the F4H when it comes right down to twisting and turning I await your reply

D R Forn
Lt, USN
Jacksonville, Fla

(Leading and trailing edge flaps of the F4H can be extended at 230 kt IAS giving the advantage of boundary layer control In the unlikely event the F4H got into an old-fashioned style fight turn dogfight and speed dropped to this level, boundary layer control could be utilized Whether the F8U could out-turn the F4H depends on altitude and speeds At subsonic speed at 35,000 ft the F8U would have the edge Higher altitude and speed would favor the F4H—Ed)

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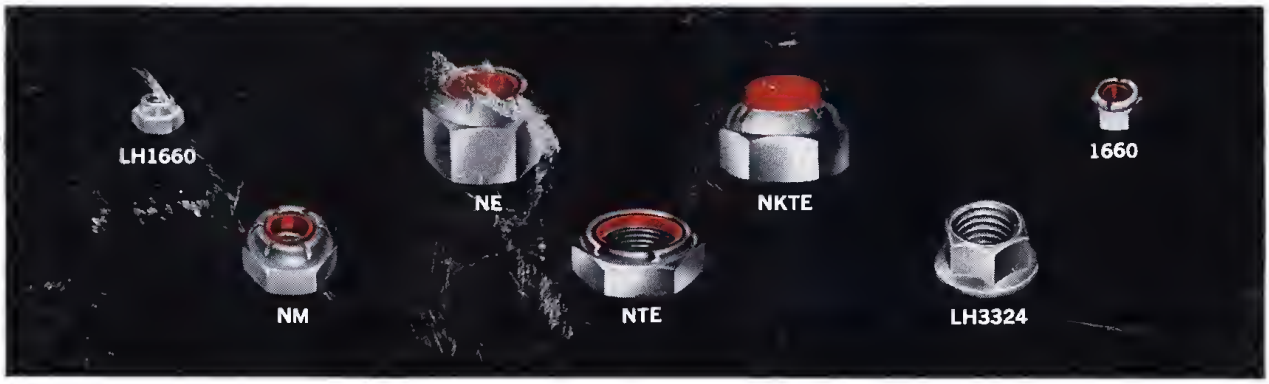

HEX TYPES

ESNA hex nut thread sizes range from a miniaturized 0-80 through standard SAE 1½"-12—and up. Designers have a choice of two types of reliable self-locking devices—depending on operational temperatures. Both types have received military approval and most parts are produced in carbon and stainless steels.

For temperatures up to 250° F., the high-reuse nylon insert type is recommended. For temperatures of 550° F. or 900° F. and higher, the all-metal offset closure provides excellent self-locking results. Nylon insert nuts can be reused a minimum of 50 times on a standard screw and still retain locking torque. Nylon will not gall bolt threads or peel cadmium from the screws to foul or short vital circuits. Its dielectric strength and volume resistivity are extremely high. Nylon caps, available in most configurations, prevent "corona" effect, seal bolt ends, protect wires from chafing on bolt edges.

All-metal nuts using ESNA's elliptically offset locking device provide excellent re-usability because of their high hardness.

CHASSIS TYPES

Clinch types fasten to chassis or console by single hole mounting. Available in standard sizes and in new miniature flush mounting types; both all-metal for 550° F. temperature and with special nylon inserts for 350° F. operating environments. Also a new floating clinch nut which gives the economy of single hole mounting plus float to compensate for minor screw or component misalignment. Both standard and miniature clinch types are available with nylon caps. For other "black box" uses there are miniature right-angle "floaters," heavy duty fixed anchors for drawer slides. There is also type LH4786, a new captive washer electric terminal nut.

The new ESNA catalog no. 960 shows the hundreds of configurations—with nylon inserts, nylon caps, or in all-metal designs—of ELASTIC STOP® nuts that are available as standard parts. Why not send for your copy today? We'll be glad to send sample nuts for testing, too. Just specify type and size. Write: Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey. Dept. 560-825.

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